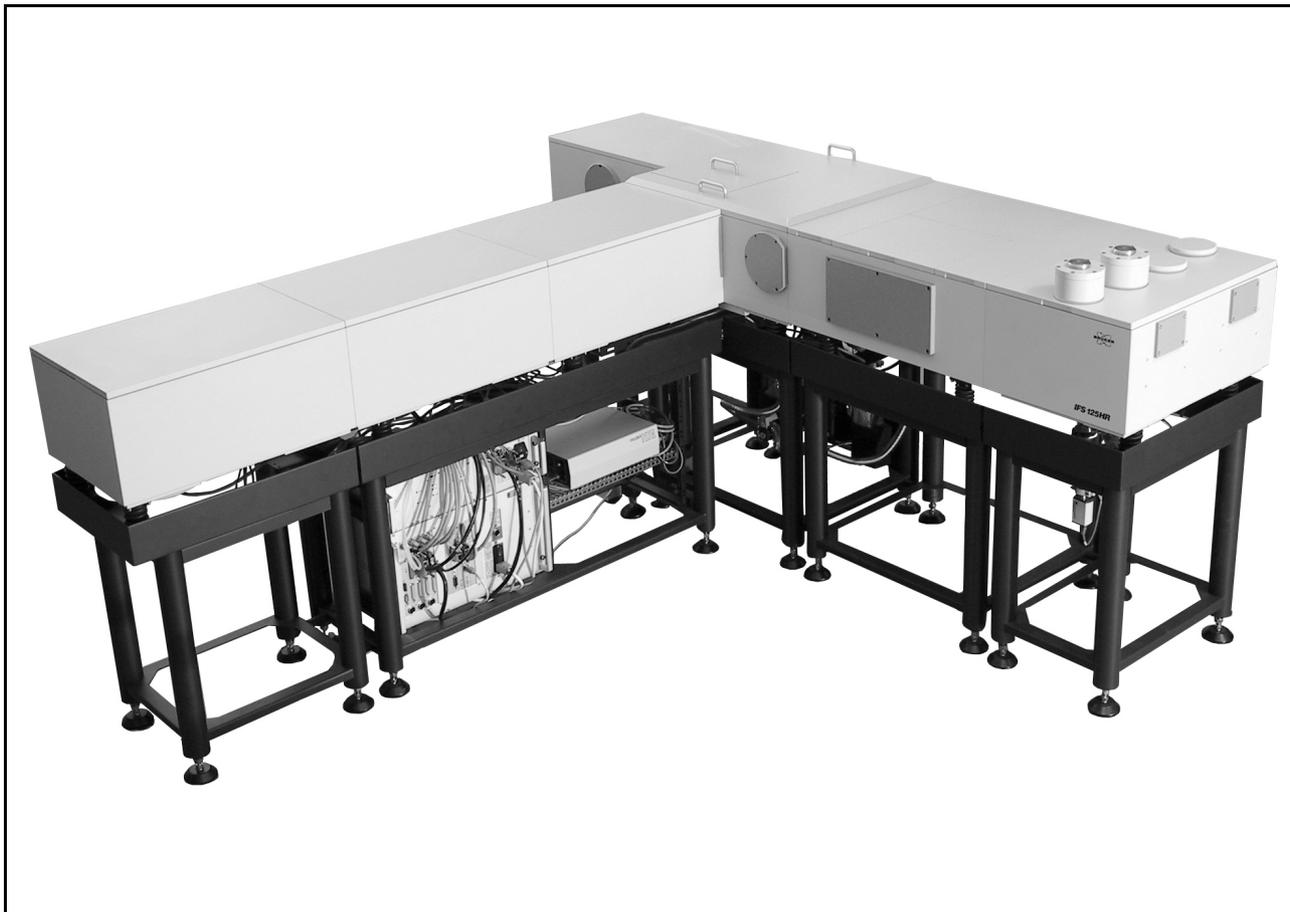


# IFS 125HR



## User Manual



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refers to hardware revision as of February 2006  
refers to firmware revision 1.440

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This manual is the original documentation for IFS 125HR.

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# SAFETY

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Read the following safety instructions carefully before operating the spectrometer and keep this manual for further reference available at any time. Always observe the instructions described in this manual to ensure user safety and to avoid property damage. Improper use or failure to follow these safety instructions can result in serious injuries and/or property damage. Any non-observance will infringe the intended use (i.e. spectroscopic measurements) of the spectrometer. In this case Bruker Optik GmbH will not assume any liability.

It is the operator's duty to plan and implement all necessary safety measures and to supervise their observance. Moreover, the operator must ensure that the spectrometer is in proper functioning condition. A safe and faultless operation can only be guaranteed if the spectrometer is transported, stored, installed, operated and maintained properly according to the procedures described in this manual.

Never remove or deactivate any supporting safety systems during spectrometer operation. Objects and/or material not required for operation must not be kept near the spectrometer operating area.

The spectrometer complies with the IEC/EN 61010-1 safety regulations.

## GENERAL INFORMATION

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### Protective Earthing

To avoid personal injuries and/or property damage caused by electrical power, the spectrometer is equipped with a safety plug. Connect this plug only to a socket outlet with earthing contact. Make sure that the connected socket complies with IEC (International Electrotechnical Commission).

### Qualified Personnel

Primary installation and all maintenance and repair not described in this manual should only be performed by Bruker service personnel. Make sure that the spectrometer is only operated and maintained (i.e. only maintenance works that are described in this manual) by authorized operating personnel trained in the spectrometer operation and all relevant safety aspects.

All repairs, adjustments and alignments on any spectrometer component must be performed in accordance with the safety regulations and standards applied in the country where the instrument will be installed.

## Correct Usage

The spectrometer and its components should only be used according to the instructions described in the manual or advised by a Bruker engineer. In case of accessories or components made by other manufacturers and used in connection with the spectrometer, Bruker does not assume any liability for safe operation and proper functioning.

## WARNING LABELS

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When operating the spectrometer you have to observe a number of safety instructions which are highlighted by various warning labels. This section describes the warning labels and explains their meaning. All warning labels on the spectrometer must always be kept legible. Immediately replace worn or damaged labels.

The following warning labels indicate different dangerous situations which may be caused by improper use of the spectrometer.



### Caution - General Hazard

This warning symbol indicates general hazard. Observe the safety instructions and follow the precautions described to avoid personal injury and/or property damage.



### Caution - Electric Shock

This warning symbol indicates electrical hazard. The symbol is located near live parts or on enclosures behind which are live parts that represent an accidental contact hazard. Never touch these parts. Before removing the corresponding compartment covers and beginning any maintenance or repair work, first turn off the main power switch and unplug the main power cable. Ensure that all live parts do not come into contact with a conductive substance or liquid. Non-observance of these safety instructions can cause severe personal injury and/or property damage.



### Caution - Hot Surface

This warning symbol refers to components and surfaces which can become very hot during spectrometer operation. Do not touch these components and surfaces. Risk of skin burn! Be careful when operating near hot components and/or surfaces.



### **Caution - Laser Radiation**

This warning symbol indicates the existence of laser radiation. Never look directly into the laser beam or use any kind of optical instruments to do so to avoid permanent eye damage.



### **Caution - Frostbite**

This warning symbol indicates cryogenic materials (e.g. liquid nitrogen) required to operate the spectrometer (e.g. cooling detector). Skin contact with these liquids or cooled components causes severe frostbite. Always handle the liquids with utmost care. Observe the safety instructions for handling of cryogenic liquids.



### **Caution - Harmful Or Irritant Material**

This warning label indicates the existence of harmful or irritant material (e.g. CaF<sub>2</sub> window material). Observe the safety instructions on the packaging, and the safety data sheets attached. Non-observance may cause personal injury.



### **Caution - Toxic Material**

This warning label indicates the existence of toxic material (e.g. KRS-5 material). Observe the safety instructions on the packaging, and the safety data sheets attached. Non-observance may cause severe personal injury or even death.

**Besides the dangers described above, there can also be hazards caused by the sample material. Depending on the type of hazardous substances you use, you have to observe the specific substance-relevant safety instructions. Put on the specific warning label on the corresponding spectrometer position. The label must be legible and permanently discernible. The following list exemplifies types of hazardous substances:**



### **Caution - Infectious Material**

This warning symbol indicates the possible existence of biologically dangerous and infectious material. When working with this kind of material always observe the prevailing laboratory safety regulations and take necessary precautions and disinfection measures (e.g. wearing protective clothing, masks, gloves etc.). Non-observance may cause severe personal injury or even death.

(For information on how to use, dilute and efficiently apply disinfectants, refer to the *Laboratory Biosafety Manual: 1984* by WHO - World Health Organisation.)



## Caution - Radioactive Material

This warning symbol indicates the possible existence of radioactivity. When working with radioactive material always observe the safety regulations and take necessary protective measures. Wear protective clothing, e.g. masks and gloves. Non-observance may cause severe personal injury or even death.



## Caution - Corrosive Substance

This warning symbol indicates the possible existence of corrosive substances. When working with corrosive substances always observe the laboratory safety regulations, and take protective measures (e.g. wear protective masks and gloves). Non-observance may cause severe personal injury or even death.

## Waste Disposal

Dispose all waste produced (chemicals, infectious and radioactively contaminated substances etc.) according to the prevailing laboratory regulations. Detergents and cleaning agents must be disposed according to the special waste regulations.

# SAFETY INSTRUCTIONS

---

The following sections describe all relevant safety aspects when operating an FT-IR spectrometer. Depending on the degree of hazard the safety instructions are classified as follows:

- Danger** indicates that death, severe personal injury or substantial property damage **WILL** result if proper precautions are not taken.
- Warning** indicates that death, severe personal injury or substantial property damage **CAN** result if proper precautions are not taken.
- Caution** indicates that minor personal injury or property damage **CAN** result if proper precautions are not taken.
- Note** draws your attention to particularly important information on the product, e.g. product operation or to a special part of the manual.

The safety instructions **Danger**, **Warning** and **Caution** are indicated by triangular warning labels which will be described in this manual.

# GENERAL

---

IFS 125HR is a high resolution research FT-IR spectrometer with modular vacuum optics for measurements in a broad spectral range. The spectrometer may be used to resolve highly complex gas phase spectra into discrete lines for recognition and spectral assignment. The interferometer design ensures a high energy throughput and low polarization effects.

## SPECTRAL RANGE

---

The standard spectrometer configuration is designed for data acquisition in the mid IR region. Optionally, IFS 125HR can be equipped with additional optical components to cover the whole spectral range - starting from the far IR region at  $5\text{cm}^{-1}$  up to the ultraviolet spectral range above  $50,000\text{cm}^{-1}$ .

Due to the pre-aligned optical components and the permanently-aligned interferometer which employs retroreflecting mirrors, the spectral range can be easily changed.

## DESIGN

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Modular vacuum cabinets sealing the source, interferometer, sample and detector compartment provide easy access to the main optical components.

The sample chamber can be separately evacuated or vented. Sources, input field stop, optical filters, sample channels and detectors can all be selected by the software without breaking the vacuum.

A removable cover lid provides access to the beam splitter for easy exchange. A total of 6 detectors and 4 sources can be used in connection with each of the two different sample compartments, giving quick access to optimized components with the highest sensitivity in each spectral range.

IFS 125HR has up to 4 IR-beam outlet ports (on the right and left side) and 1 IR-beam inlet port allowing the connection to a multitude of optional accessories and/or components like:

- External emission sources
- Long path gas cells, Supersonic Jet apparatus and other user devices
- IR microscope
- FIR bolometer

Diagnostic routines help to maintain optimum instrument status and performance.

**Note:** Depending on the spectrometer configuration ordered, your spectrometer may not include all options that are described in this manual.

## ELECTRONICS

---

Functions such as ACR (Automatic Component Recognition) and check of measurement parameters allow fast and reliable FT-IR spectroscopic measurements. Optical components e.g. detector and beam splitter are electronically coded so that the spectrometer firmware can recognize them. In addition, the permanent online check of spectrometer components facilitates error diagnostics and maintenance.

The data acquisition is based on a free running delta-sigma A/D converter with 24 bit dynamic range. The A/D converter is integrated into the detector preamplifier electronics. The DigiTect™ technology ensures a signal transmission which is free from interferences, and guarantees the highest signal-to-noise ratio.

IFS 125HR can be controlled by any data system (PC workstation, notebook), provided the Microsoft Windows™ operating system and the OPUS™ spectroscopic software have been installed. The Ethernet connection allows to control the spectrometer also via intranet or internet.

# INSTALLATION

---

Unpacking and initial installation of IFS 125HR is done by Bruker service engineers. The operating company has to provide an installation site that meets the site requirements described in this chapter.

This chapter includes standard as well as optional spectrometer components and describes the standard procedures for connecting IFS 125HR to a PC, and installing the vacuum connection. To install the computer, refer to the computer manual.

## DELIVERY CONTENTS

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The basic IFS 125HR spectrometer allows upgrading with additional components and/or accessories. Depending on the spectrometer configuration ordered your delivery contents may not include all optional components listed below.

### Standard Components

The basic spectrometer configuration includes the following components:

- IFS 125 HR
- Power cable
- Data cable (10Base-T cross-over cable; length: 10m)
- OPUS™ spectroscopic software (instrument control, data acquisition, manipulation and evaluation)
- IFS 125HR user manual
- Spare parts

### Optional Components

The following items **may** also be included, depending on the IFS 125HR configuration ordered:

- PC compatible data system (including Windows™ operating system)
- Other OPUS™ application software packages (e.g. QUANT, IDENT) and the relevant manuals
- Accessories

## Packaging

After receiving the spectrometer, inspect the packaging for damages. If there are any signs of damage, contact your local shipping representative before opening the shipping box.



**Warning:** Do not put a spectrometer into operation that shows signs of damage. Any non-observance could cause personal injury and property damage.

## Transportation

Due to its substantial weight (>500kg) the IFS 125HR spectrometer should not be carried after primary installation. Contact a Bruker specialist if a relocation should become necessary.

# SITE REQUIREMENTS

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The spectrometer has to be placed on a plane floor which is able to bear the weight of more than 500kg. An optional high resolution scanner requires more space (see floor plan in appendix D). To guarantee long component and service life the following site requirements have to be observed.

## Space

The physical dimensions of the IFS 125HR optics bench are:

- Optics without scanner: 165 x 80 x 97cm (w x d x h)
- Scanner: 39 x 114 x 97cm
- Scanner options: between 39 x 171 x 97cm and 39 x 513 x 97cm
- Service unit: 30 x 23 x 28cm (w x d x h)

When installing the spectrometer make sure that the spectrometer connection to the main power supply can be accessed at any time. The main power supply can be interrupted, e.g. either by disconnecting the safety plug, switching off the main power switch at the source control panel (figure 71), or disconnecting the appliance inlet connectors.

Make sure that at least 25cm (10") clearance<sup>1</sup> is available at all spectrometer sides, and that the distance between data system and spectrometer optics does not exceed 10m. A longer distance is possible, if you use an appropriate data cable (see appendix E and F).

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1. This clearance does not include the space required for a convenient access to the spectrometer components or the sample compartments.

## Environment

To ensure optimum spectrometer performance and long-term reliability the following environmental conditions are essential:

Temperature Range: 18 - 35°C (64 - 95°F)  
Humidity (non-condensing): Less than 80% (relative humidity)

For further details, see appendix A.

Temperature variations can impair the results of long-term measurements. Therefore, temperature variations should be less than 1°C per hour and not more than 2°C per day for this type of measurements.

## Vibration

To protect the instrument from vibration IFS 125HR is equipped with a vibration insulation between the vacuum housing of the optics and the supporting frame. Nevertheless, make sure that the instrument is not located near vibration sources (ventilation hoods, air conditioners, motors etc.).

**Caution: Avoid any rigid connection between the vibration source (e.g. pump) and the vacuum housing. If you have to evacuate accessories, a flexible connection to the pump is required.**



## Power Supply

The spectrometer employs several sub-units requiring electrical power supply, such as

- source power supply
- controller
- laser power supply
- source cooling system<sup>1</sup>
- vacuum pump (see separate manual describing the valid voltage range)

### Standard:

Valid voltage: 230VAC  $\pm$ 10%  
Valid frequency range: 50Hz to 60Hz<sup>1</sup>

---

1. The source cooling system works only at a fixed fine frequency. Make sure that the frequency indicated on the label attached to the source-cooling system is conform with the frequency provided by the main power supply.

**Option (for USA, Canada):**Valid voltage: 115VAC  $\pm$ 5%

Valid frequency: 60Hz

In case of a 115VAC power supply you have to use a special transformer unit. Make sure that the 115VAC cable with the inlet connector for non-heating apparatus (C in figure 1) is connected to the main power supply, and the 230VAC cable (A in figure 1) to the main spectrometer power (B in figure 1).

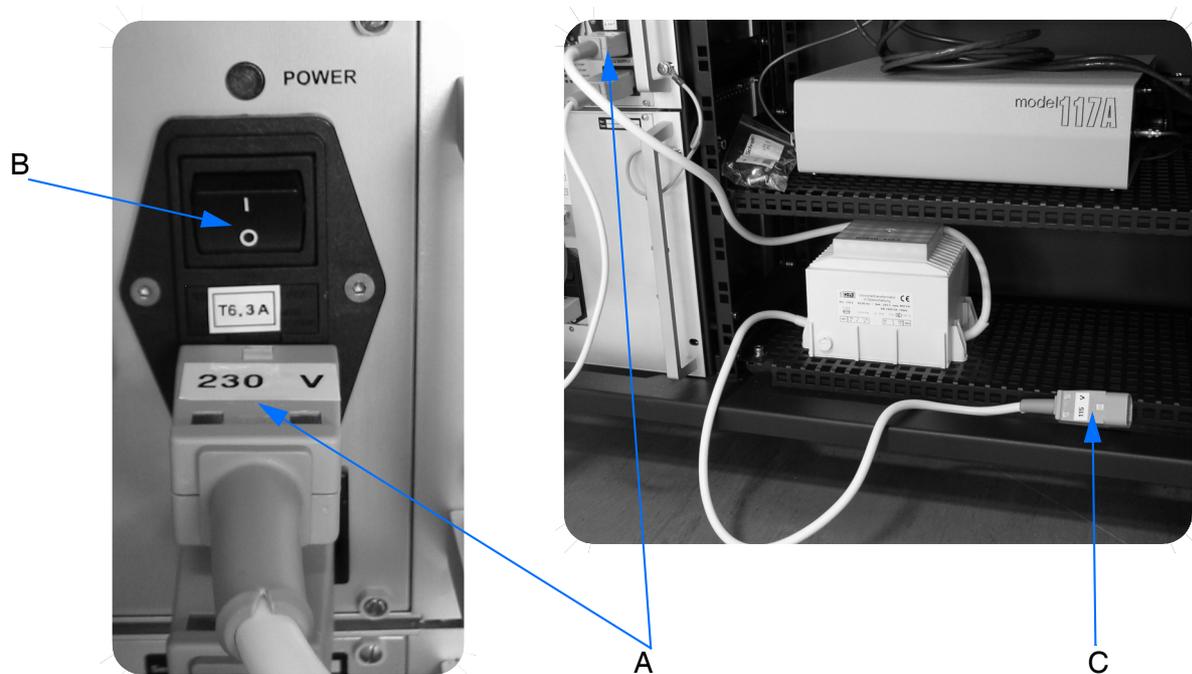


Figure 1: IFS 125HR - Transformer connection for 115V operation

The IFS 125HR spectrometer is an instrument of Protection Class I.



**Caution: When operating IFS 125HR make sure that the spectrometer is only connected to a socket outlet with earthing contact to avoid personal injury and spectrometer damage.**

If you connect external accessories to an IFS 125HR interface such as R232 (serial), Ethernet or LPT1 (parallel), make sure that these accessories comply with the requirements outlined in EN 61010 or EN 60950. This means that you always have to connect a SELV circuit (Safety Extra Low Voltage Circuit) to a corresponding SELV circuit and not to any other type of circuit.

## Electromagnetic Compatibility (EMC)

The spectrometer is carefully shielded (CE). However, to provide better data quality and a long spectrometer service life make sure that the following site requirements are met:

- Do not locate the spectrometer near any sources of potential inductive electrical interference (e.g. pumps - except for the one supplied with the spectrometer -, switching motors, microwave ovens etc.), sources of high energy pulses, and sources that might cause magnetic or radio frequency interference.
- Do not locate devices such as large electric motors, heaters, welding equipment, radio transmitting equipment, units emitting pulsed NMRs, or high-powered lasers in close vicinity to the spectrometer. These devices can interfere with the spectrometer and cause spectrometer malfunction. Make sure that these types of devices are not connected to the same electrical circuit as the spectrometer.
- Take precautions to ensure an uninterruptible power supply if main power reliability is a problem at your site caused by, e.g. brownouts, power surges, frequent thunderstorms.

## CONNECTING IFS 125HR TO A PC

### Power Cord

Before connecting the power cord, make sure that the spectrometer is switched off, i.e. the main power switch at the source control panel (figure 71 on page 156) has to be in the OFF position. Connect the spectrometer power cord to the appropriate socket (O in figure 71) at the spectrometer controller as well as to the mains socket outlet.<sup>1</sup>

Depending on the local requirements and regulations, the original power cord may need to be replaced by a power cord commonly used within the particular country. The cord must be technically approved by the local authority, e.g. UL for USA, CSA for Canada or VDE for Europe, and the cable length must not exceed 3m.

**Note:** Replace the power cord if any damage to the insulation, connectors or cable is visible. Do not repair it! Replace the power cord only by cords rated for at least 250VAC, 10A.

### Data Cable

The data cable supplied with your spectrometer is a CAT-5 type cross-over cable (labelled *Cross-over*) with two RJ-45 plugs. This cable is only used to directly connect IFS 125HR to a computer. If you want to connect the spectrometer to a network, a

---

1. See *Power Supply* section for optional 115V operation in this chapter.

different type of cable is required (see appendix E). In this case use a normal (i.e. not cross-over) CAT-5 10Base-T data cable.

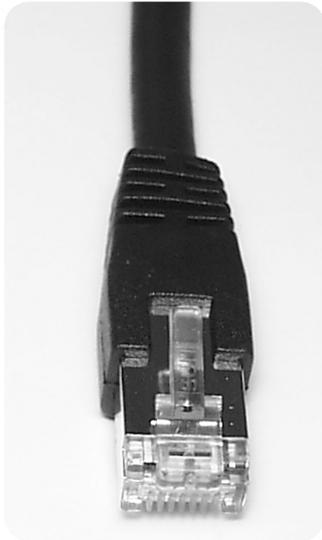


Figure 2: CAT-5 data cable with RJ-45 plug

Connect one end of the cross-over data cable to the ETH socket on the spectrometer electronic panel (figure 67) and the other end to the RJ-45 socket of the computer network interface card. For detailed information, refer to the computer manual. The data cable length must not exceed 100m.

After setting up the data cable connection, turn on the spectrometer using the main power switch (B in figure 1). After a few seconds, the spectrometer beeps once and starts a self test. The red ERR and SR LEDs turn off (see figure 67 on page 147) after a successful initialization which may take up to 2 minutes. Switch on the computer and the monitor.

For information on how to install the computer and how to set up signal and power cable connections for the computer, monitor etc. refer to the computer manual.

## CAN Bus Cable

Some Bruker accessories require a power supply via CAN bus. If such an accessory is installed, connect the CAN bus cable to one of the CAN bus connectors (see figure 68 on page 151 and figure 69 on page 153). Ensure that the plug is secured properly.

## Computer Setup

IFS 125HR and the data system is already configured for stand-alone operation (see appendix E). The IFS 125HR IP address has been set to 10.10.0.1 by Bruker. If the IFS 125HR spectrometer is not supplied together with a computer, you have to assign an appropriate IP address to the computer you want to connect to IFS 125HR. For any further details on how to assign an IP-address to the computer and/or spectrometer refer to appendix E.

**Note:** In case of high-resolution measurements sufficient computer resources (storage capacity) are required. When performing such measurements make sure that any other software program is closed. Otherwise, problems may occur.

## INSTALLING THE VACUUM AND VENTING GAS CONNECTION

IFS 125HR includes two KF flanges.

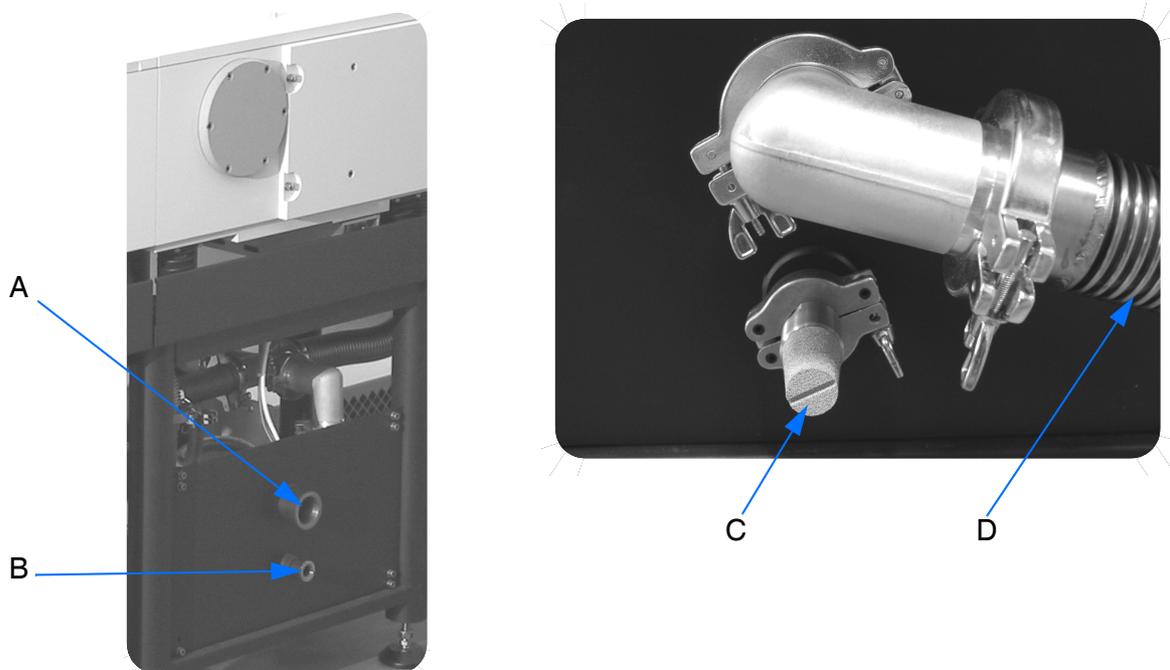


Figure 3: IFS 125HR - KF flanges

The DN40KF connector (A in figure 3) is the vacuum port which has to be connected to the vacuum pump, by using a stainless steel flexible hose (D in figure 3). The length of the flexible hose should not exceed 3m, otherwise longer pumping time and worse final pressure will result.

**Note:** If a significantly longer hose is required, it is recommended to use a DN63 hose with 2 DN63K/40KF adapters.

Make sure that the vibration damping pot is located close to the spectrometer between two pieces of hose. Connect the exhaust port of the vacuum pump to an exhaust line. It is recommended that the exhaust line has a diameter of at least 25mm.

The DN16KF connector (B in figure 3) is the venting gas inlet. It is sealed by a silencer/particle filter (C in figure 3). In this configuration the instrument is vented by ambient air. If the ambient air is too humid or if the pumping time should be decreased, it is recommended to vent the instrument by either dry air or nitrogen.



**Caution:** A high air humidity level inside the interferometer and detector compartment as well as the sample compartment impairs the measurement results. The standard KBr beam splitter will be destroyed if exposed to high levels of air humidity for a prolonged period of time! Therefore, evacuating these compartments is highly recommended to reduce the air humidity level.

To install the venting gas connection proceed as follows:

- Remove the silencer/particle filter.
- Use a flexible hose to connect a source of either dry air or nitrogen.

**Note:** Use an appropriate pressure reducer to ensure that the maximum pressure does not exceed 1800hPa, and has a flow rate of at least 1l/s.

- For venting gas supply requirements refer to chapter 5.

## Installing Source Cooling System

The source cooler unit should be connected to the SOURCE COOLER power socket (B in figure 73 on page 161).

**Note:** If the instrument is configured for 115V operation (see *Power Supply* in this chapter), the source cooler must not be connected to this power socket. Directly connect it to the mains power supply.

## Installing Starter Unit for Vacuum Pump

- Connect the remote cable of the starter unit to the VACUUM PUMP power socket at the peripheral control panel (see C in figure 73 on page 161).
- Connect the vacuum pump and the security valve according to the separate manual of the starter unit.

# DESCRIPTION

This chapter describes all relevant spectrometer components. Depending on the spectrometer configuration your instrument may look different. Modular vacuum compartments sealing the source, interferometer, sample and detector provide easy access to the main optical components.

The IFS 125HR spectrometer consists of the following compartments:

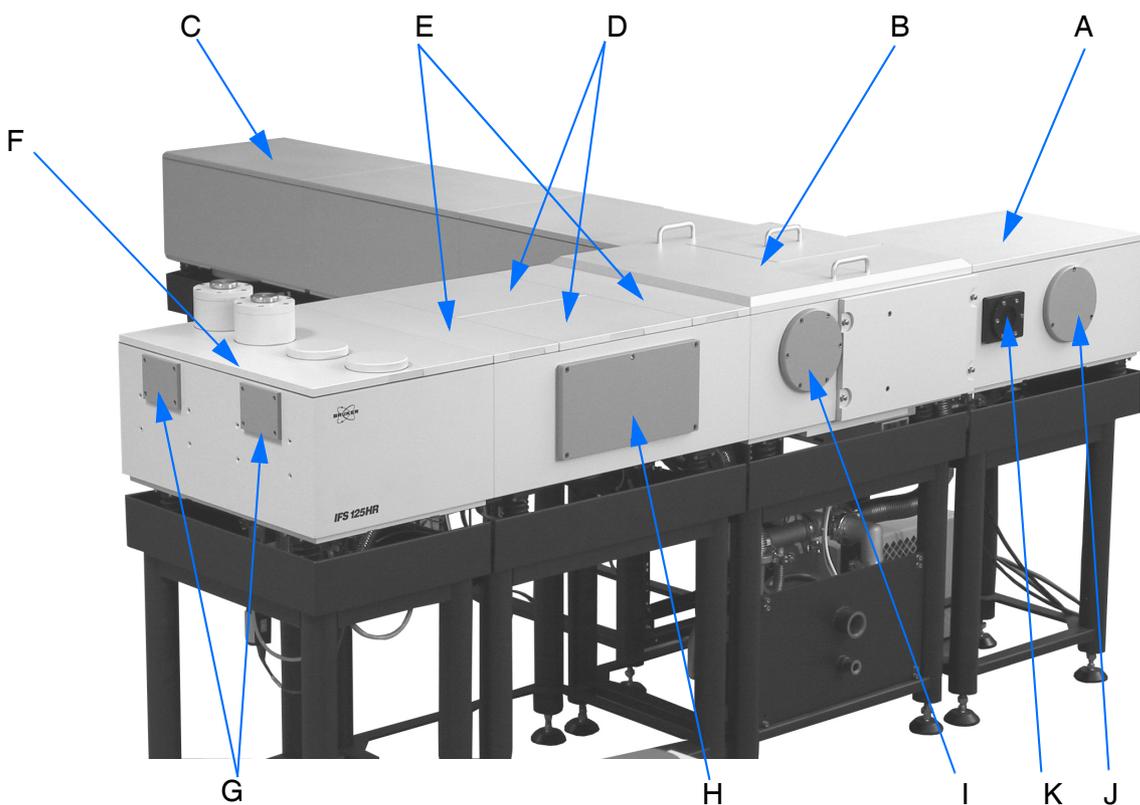


Figure 4: Front view of IFS 125HR showing the different compartments

	Definition
A	Source compartment (enlarged version shown)
B	Interferometer compartment
C	Scanner compartment
D	Sample compartments
E	Channel switching sub-chamber
F	Detector compartment
G	Detector outlet ports
H	Cover plate, provides access to large accessory
I	Outlet port for parallel beam
J	Input port for parallel beam
K	Input port for focused beam

An inner o-ring (A in figure 5) provides the vacuum seal, and an outer conductive textile sealing (B in figure 5) completely shields the compartments from exterior electromagnetic radiation. The ports are equipped with both an o-ring and an EMC gasket.

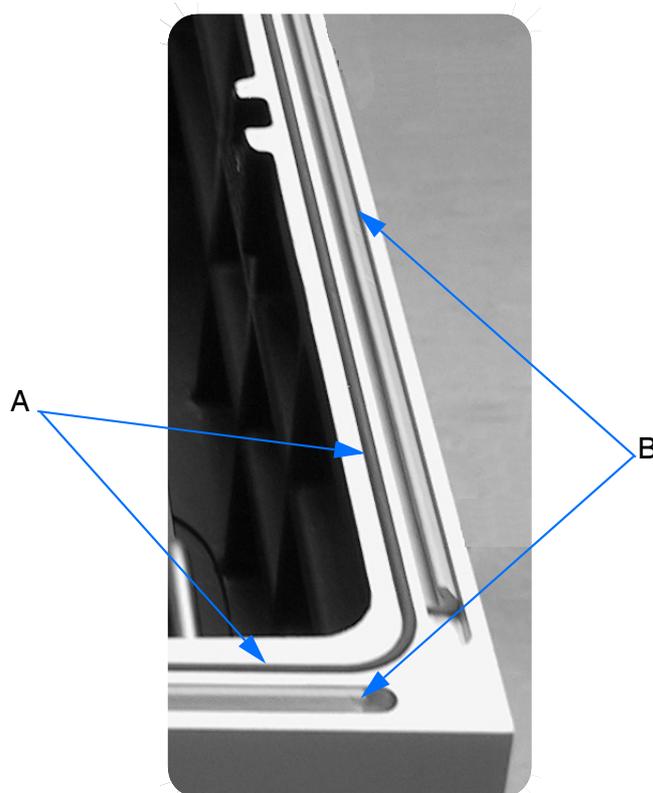


Figure 5: IFS 125HR - Compartment sealing

## GENERAL

IFS 125HR includes a closed-loop coolant system for the sources, and a double-stage mechanical vacuum pump which evacuates the bench to a level of <math><0.02\text{hPa}</math>.

During operation IFS 125HR generates laser radiation and high voltages in some of the electronics.

Do not touch any component inside the spectrometer (even if power is off) without first reading the appropriate chapters of this manual.

**Caution: Do not place any object on top of the spectrometer. In case of non-observance the object may fall inside and damage components if any of the compartment covers is removed.**



Furthermore, heavy objects placed on the scanner compartments may cause a deflection of the mechanical structure and affect the optical alignment.

**Caution: Make sure that all compartments have their covers closed and secured to prevent laser and source radiation from being emitted by the spectrometer, and avoid external contamination to protect the spectrometer optics. Improper use may cause health hazards and spectrometer damage.**



**Therefore, any deviation from maintenance procedures described in chapter 6 must be approved by a Bruker service engineer or application specialist.**

IFS 125HR uses a permanently-aligned modified Michelson interferometer for (mostly) single-sided acquisition up to an optical path of 144cm (option: up to 942cm). The interferometer design ensures a high energy throughput and low polarization effects.

Optional signal inlet ports for collimated and focused radiation from an external source are provided at the rear side of the optics module. Available options include outlet ports for collimated radiation, a vacuum shutter for a parallel exit to add evacuable accessories or an additional detector chamber for the exit port.

## Electronics

The spectrometer electronics are based on a high speed, free running delta-sigma 24 bit ADC (Analog Digital Conversion) that guarantees results with an outstanding accuracy. The A/D converter is integrated into the detector housing.

Any modern data system (PC workstation, laptop etc.) with the Microsoft Windows™ 2000 or XP operating system and OPUS™ spectroscopic software can be used to control the instrument and perform measurements. IFS 125HR is linked to the data system by a standard 10Base-T Ethernet connection with TCP/IP, and allows the spectrometer to be integrated into an existing data network.

IFS 125HR is completely software controlled. All components<sup>1</sup> can be selected and operated using the OPUS™ spectroscopic software. Diagnostic routines help to maintain optimum status and maximum performance of the instrument. Additionally, the optics controller can directly be accessed by any internet browser for diagnostic purposes or even test measurements.

## Source Cooling System

The IFS 125HR spectrometer is supplied with a closed-loop cooling system. Depending on the cooling unit model the water capacity varies between 2 to 4 liters. Make sure that distilled or deionized water is available to have the unit filled to the proper level.

**Note:** Always fill the cooling unit with distilled or deionized water only. Change the water regularly.

For care and maintenance of the cooling unit refer to chapter 6.

## External Vacuum System

Pump, demister, bellows, pipes and valves are integrated to evacuate and vent the optical bench. The spectrometer optics can be evacuated down to less than  $2 \times 10^{-2}$  hPa. An exhaust line for the vacuum pump is recommended. The exhaust line should have a diameter of 25mm/1" or larger. The starter box allows a remote control of the vacuum pump.

---

1. Exceptions: beam splitter exchange, switching on/off a Xe or deuterium source

## SOURCE COMPARTMENT

The source compartment can accommodate 3 water-cooled sources which can individually be selected by the OPUS™ software. Additionally, the compartment includes a computer-selectable port for ultraviolet sources or external emission experiments. The source beam exits at a focus to the interferometer compartment.

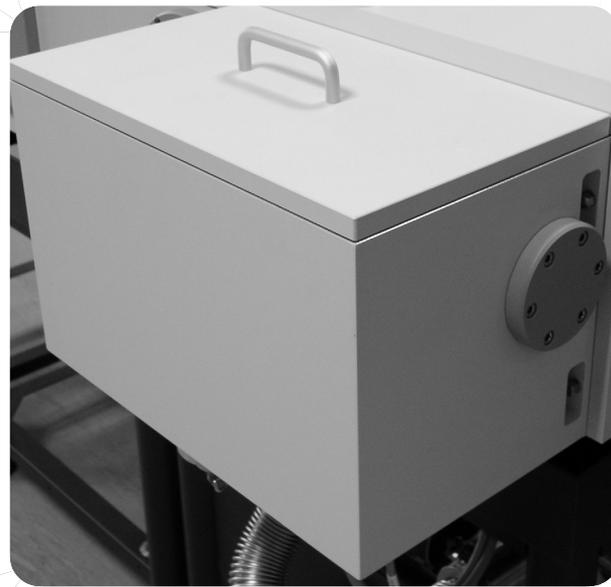


Figure 6: IFS 125HR - Source compartment, exterior view

A globar for MIR spectroscopy is the standard source for IFS 125HR. There are further options, e.g. tungsten (NIR) or xenon (UV) lamps. For further details on replacing sources, see chapter 6.

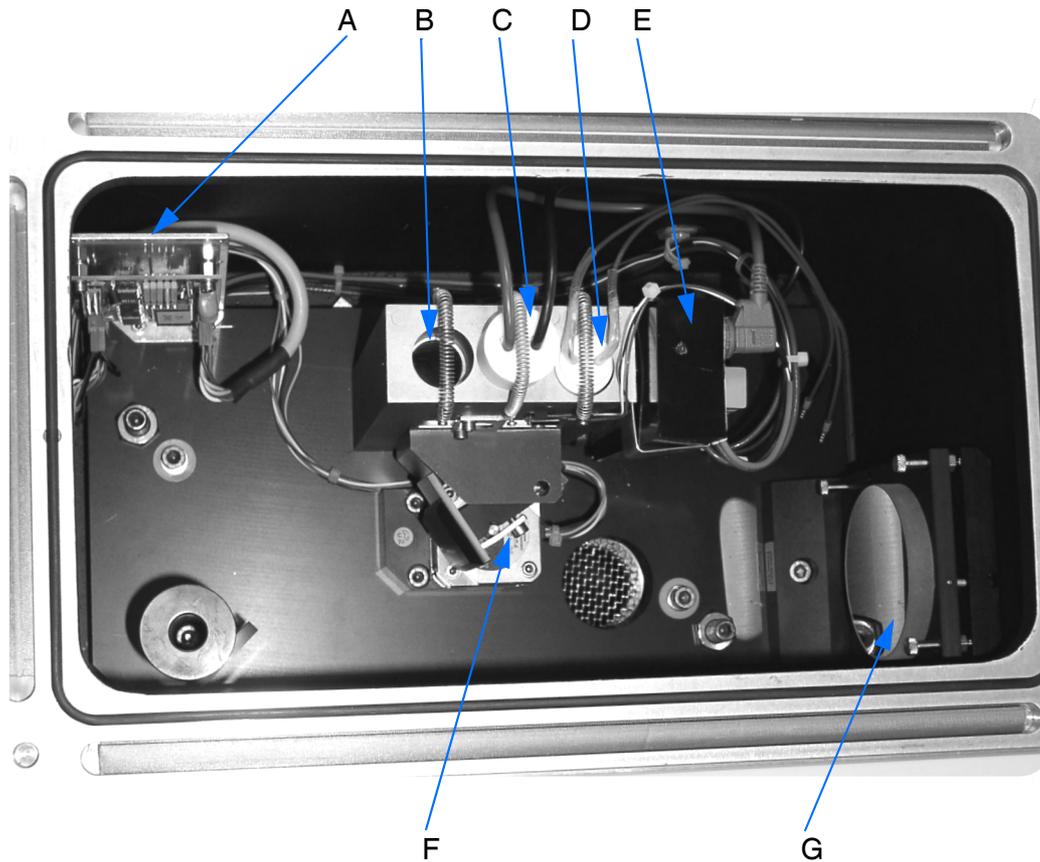


Figure 7: IFS 125HR - Source compartment, interior view

	Definition
A	Stepper motor driver (CAN bus interface)
B	NIR/VIS source
C	FIR source
D	MIR source
E	Luster terminal and starter box
F	Source selection mirror
G	Spherical focusing mirror

Optionally, an enlarged source chamber which allows the installation of up to 3 internal sources and 3 external radiation inputs can be supplied. This source chamber replaces the standard source chamber.

The source block is cooled by circulating water. To guarantee proper cooling an external closed-loop cooling unit is connected to the source compartment.

**Caution: Do not put the spectrometer into operation in case of any visible leakage of cooling water inside the source compartment! In case of non-observance this may cause severe damage to optical components, especially when evacuating.**



## External Source Cooling Unit



Figure 8: External cooling unit, front and side view

The external closed-cycle cooling unit can be connected to the most common power supply sources.

### **Standard:**

Valid voltage range: 210VAC to 240VAC

Valid frequency range: 50Hz

### **Option (for USA, Canada):**

Valid voltage range: 115VAC

Valid frequency range: 60Hz

**Note: To guarantee proper operation of the external closed-loop cooling unit make sure that the coolant reservoir (A in figure 8) is always sufficiently filled. The coolant level must not drop below the minimum level indicator.**

To realize the connection between source compartment and cooling unit, the latter is flange-mounted to the bottom end of the source compartment (see figure 9). For details on how to properly install the power cable of the cooling unit, refer to chapter 3.

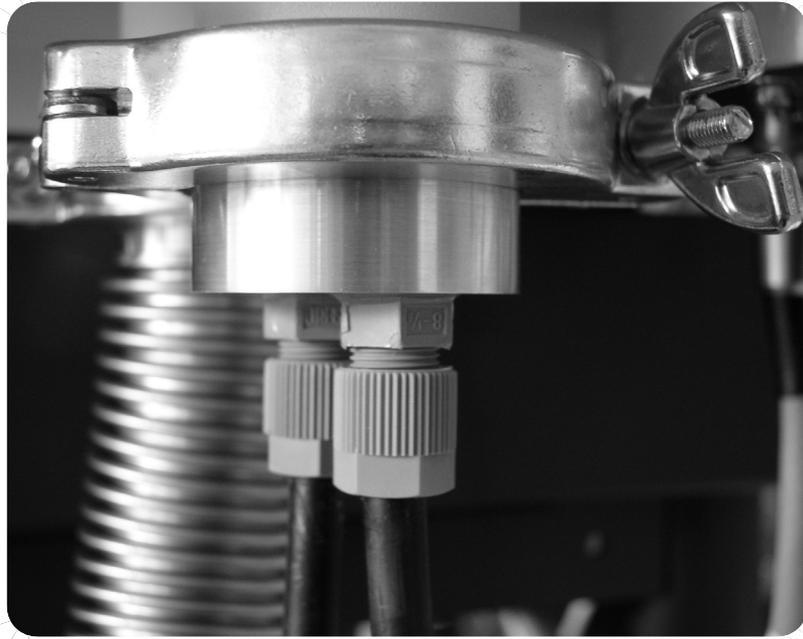
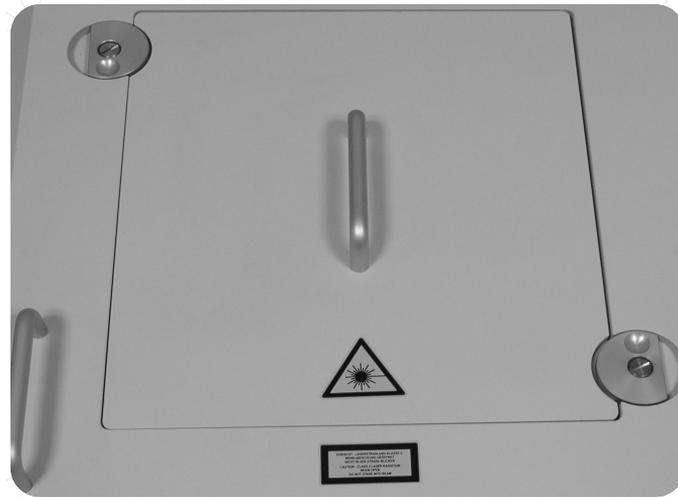


Figure 9: External cooling unit flange mounted on source compartment

## INTERFEROMETER COMPARTMENT

The interferometer compartment includes a permanently-aligned interferometer with retroreflecting mirrors and a beam splitter, and uses a stabilized HeNe laser to exactly determine the optical path difference.

The large interferometer compartment top cover with the laser warning labels also integrates a smaller lid which facilitates the exchange of the beam splitter. For further details on how to change the beam splitter, refer to chapter 5.



Top cover



Front view



Rear view

Figure 10: IFS 125HR - Interferometer compartment with laser warning labels and output ports

The interferometer has a 30° angle of incidence. This narrow angle of incidence reduces polarization effects and uses the beam splitter more efficiently. The beam is split to the fixed and moving cube corner mirror of the Michelson interferometer.

The moving mirror is translated on a hybrid bearing. This bearing design allows a beam integrity over extremely long optical path differences, which may be longer than 900cm.

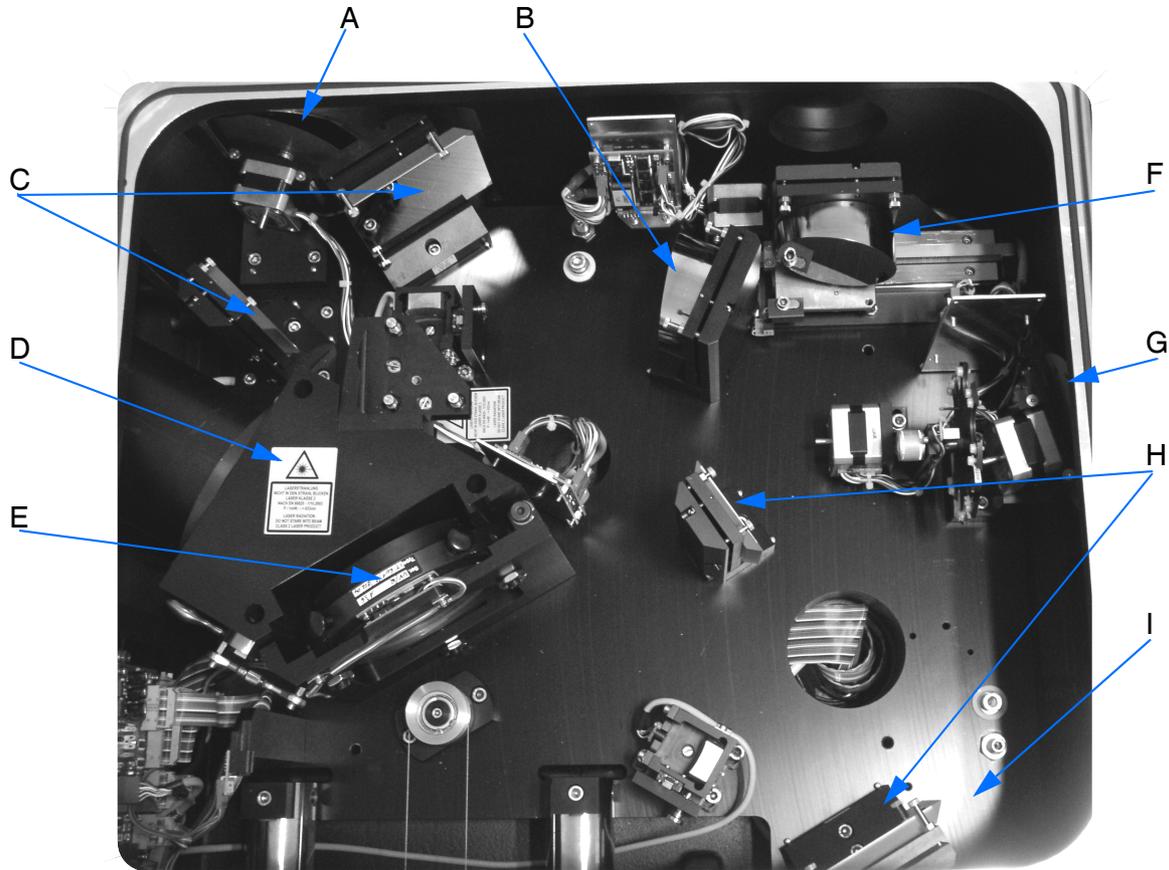


Figure 11: IFS 125HR - Interferometer compartment

	Definition
A	Input aperture (field stop)
B	Collimating parabolic mirror
C	Flat mirrors
D	Laser warning label
E	Beam splitter
F	Focusing parabolic mirror
G	Output aperture (field stop)
H	Flat mirrors
I	Base plate

An interferometer option for double-sided (symmetrical) acquisition of interferograms up to an optical path difference of 50cm is also available. This option includes a vacuum chamber for the fixed retroreflector and an alignment device. If this option has been installed, the maximum optical path difference for one-sided acquisition will be shortened by 50cm.

## Laser Module

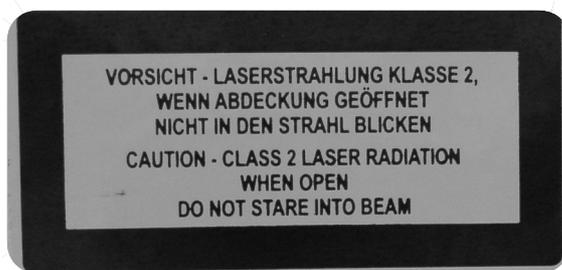
The laser controls the position of the moving interferometer mirror (also called *scanner*) and is used to determine the data sampling positions. The monochromatic beam produced by the frequency stabilized HeNe laser is modulated by the interferometer. In case of a uniform scanner motion a sinusoidal signal is generated.

## Laser Safety

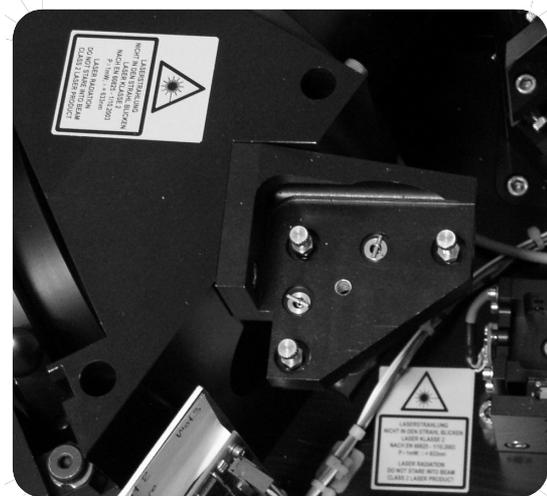
IFS 125HR is equipped with an HeNe laser which emits red light with a wavelength of 633nm. The rated laser power output inside the interferometer compartment is 1mW (laser class 2 per EN 60825-1/10 2003). IFS 125HR is a LASER CLASS 2 PRODUCT.

During normal spectrometer operation the IFS 125HR compartments are completely sealed and no laser radiation emits. With the interferometer compartment being open laser radiation will emit. The intensity of this laser radiation is considered not to impose any health hazards as long as any direct intrabeam exposure to the eyes is avoided.

The laser warning labels define safety instructions on laser radiation and are located on the interferometer compartment top cover as well as on the front and rear interferometer compartment side.



Exterior view



Interior view

Figure 12: Laser warning labels



**Caution:** Laser light is generated within the instrument, as soon as the main power switch is turned on. Reflections off objects in any compartment (FT-IR accessories, mirrors) can cause laser light to emit from that compartment.

Do not operate the spectrometer if the covers are removed or appear damaged. Never look or use optical instruments to look into the laser beam or its reflection off any surface. Directly looking into the laser beam can cause permanent eye damage. Wear safety goggles when aligning the laser beam.

**Caution:** Do not remove the red filter from the base plate at the input port of the laser beam. This will exceed the laser power limit specified for CLASS 2!

In case of maintenance it may be necessary to remove or exchange the HeNe laser module. **Contact the Bruker service as this kind of maintenance work has to be done by a Bruker service engineer only.**

Be careful not to switch the laser on and off several times in succession. This may shorten the component lifetime significantly. Switch on again only if the laser tube has cooled down. The laser and laser frequency need a stabilization period of up to 30 minutes. The LED lamp on the laser power supply is for control purposes only and has to be checked from time to time. For maximum stability operate the laser continuously.

## Beam Splitter

To switch the spectral range the spectrometer allows to change the beam splitter. The standard beam splitter is a KBr substrate with multilayer coating and covers the MIR range.



**Caution:** A high air humidity level inside the interferometer and detector compartment as well as the sample compartment impairs the measurement results. The standard KBr beam splitter will be destroyed if exposed to high levels of air humidity for a prolonged period of time! Therefore, evacuating these compartments is highly recommended to reduce the air humidity level.

Apart from the standard beam splitter, there are other types of beam splitters available. They allow data acquisition in wavelength ranges other than MIR when used in connection with the appropriate light sources and detectors.

**Note:** The combination of light source, beam splitter and detector defines the measurement range.

The following table includes optional types of beam splitters available.

Beam Splitter	Spectral Range (cm <sup>-1</sup> )
<b><i>FIR</i></b>	
125µm Mylar® (Si bolometer D211-F required)	20 - 5
100µm Mylar® (Si bolometer D211-F required)	25 - 8
75µm Mylar®	35 - 12
50µm Mylar®	55 - 20
25µm Mylar®	120 - 30
12µm Mylar®	220 - 50
6µm Mylar®	450 - 80
3.5µm Mylar®	680 - 160
Multilayer Mylar® beam splitter	650 - 30
<b><i>MIR</i></b>	
KBr	4,800 - 450
<b><i>NIR</i></b>	
CaF <sub>2</sub>	14,000 - 1,850
<b><i>VIS</i></b>	
Quartz (II)	25,000 - 9,500
Quartz (III)	50,000 - 20,000

**Caution:** CaF<sub>2</sub> (calcium flouride) is a harmful material and may impose a health hazard when dust or particles are inhaled or swallowed. Avoid any eye and skin contact. Always observe the safety data sheet.



## Retroreflecting Mirror

The heart of the interferometer is formed by the beam splitter and two retroreflecting mirrors.

## Outlet Ports

The interferometer compartment has 2 outlet ports for connecting external accessories, see figure 10 on page 23. There are three connecting possibilities:

- 1 The accessory is directly flanged to the port and will be evacuated and vented together with the spectrometer.
- 2 A vacuum shutter is installed between the port and the accessory. This allows to vent or evacuate the accessory separately.
- 3 The spectrometer port is sealed by a window, making the vacuum system self-contained at the expense of a limited spectral range of the window and additional reflection losses. (For details on how to exchange windows, see chapter 6.)

**Note:** If the accessory to be connected is of substantial weight (approx. >10kg), it has to be supported by a separate frame.



**Caution:** If the port opening has a clear aperture of more than 4cm, the port will not be shielded any more according to EMC<sup>1</sup> as soon as the blank flange is removed. Therefore, make sure that the instrument you connect to the respective port ensures complete EMC shielding.

In particular, a conductive connection between the accessory and the spectrometer, and a complete metallic enclosure of the accessory without any slits or openings larger than 4cm are required. Unused ports have always to be covered with (metallic) blank flanges.

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1. EMC: Electromagnetic compatibility

# SCANNER COMPARTMENT

In the standard configuration the scanner compartment comprises 2 vacuum chambers. Optionally, the scanner compartment can have up to 9 chambers.

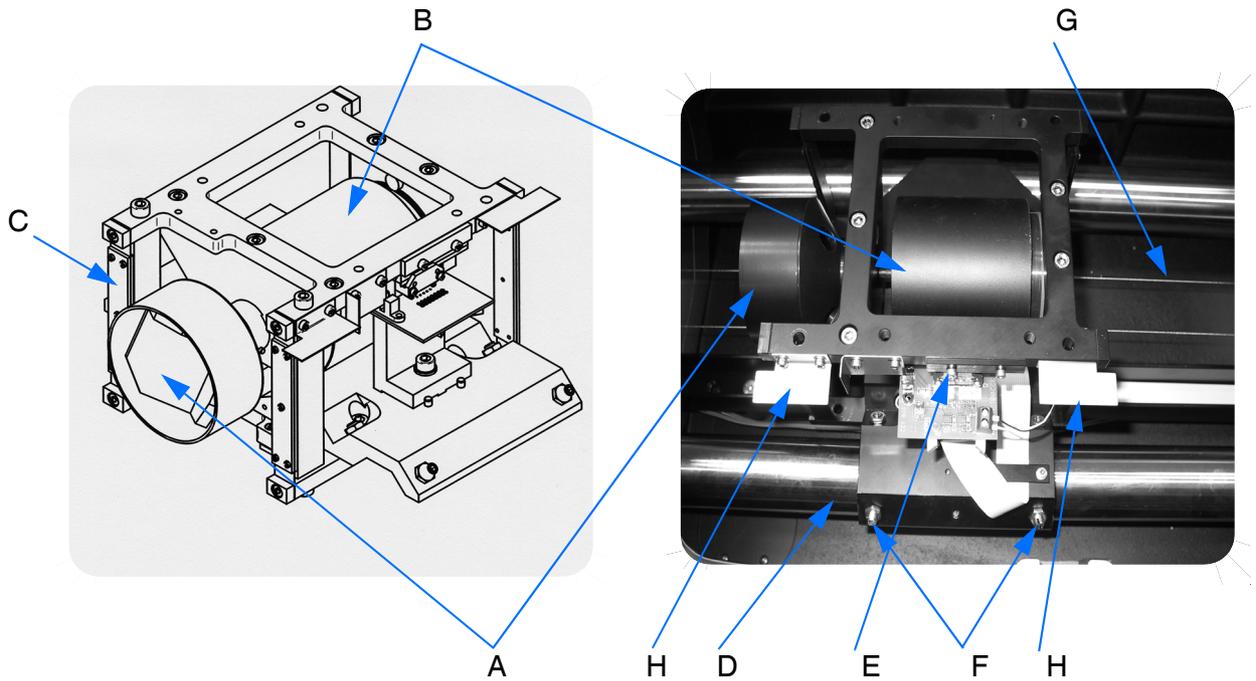


Figure 13: IFS 125 HR - Scanner

	Definition
A	Retroreflecting mirror
B	Pot magnet with moving coil (linear drive)
C	Leaf spring
D	Precision-steel rod
E	Linear encoder
F	Adjusting screws of gliding pins
G	Drive cable
H	Flag (actuator) for light barrier

The scanner is driven by 2 drive units, i.e. 1 DC (direct current) motor (A in figure 46 on page 78) and 1 linear drive unit (B in figure 13). These two drive units are also called the outer and inner scanner. As the main function of the inner scanner is to compensate

the fluctuations of the outer scanner, the outer scanner ensures the gliding movement. For low resolution measurement the inner scanner is activated, only.

Based on the laser interference signal the inner scanner compensates the fluctuations. To compensate the tilting of the inner scanner this scanner uses a displacement sensor (digital encoder).



**Caution: Make sure that the leaf springs are not bent. This may considerably impair the scanner operation. Do not touch the mirror.**

The scanner movement is controlled by the HeNe laser signals. To avoid any malfunctions with regard to mechanical scanner movements make sure that the rods are always free of any visible deposits. For details on cleaning the rods, see chapter 6.



Figure 14: IFS 125HR - Scanner compartments



## SAMPLE COMPARTMENT

There are two large sample compartments with focused beams which accommodate a wide variety of sampling accessories including long path gas cells and cryostats. A 1:1 image of the input aperture is provided at the sample position. To enhance flexibility each sample compartment can be equipped with an additional exit port.

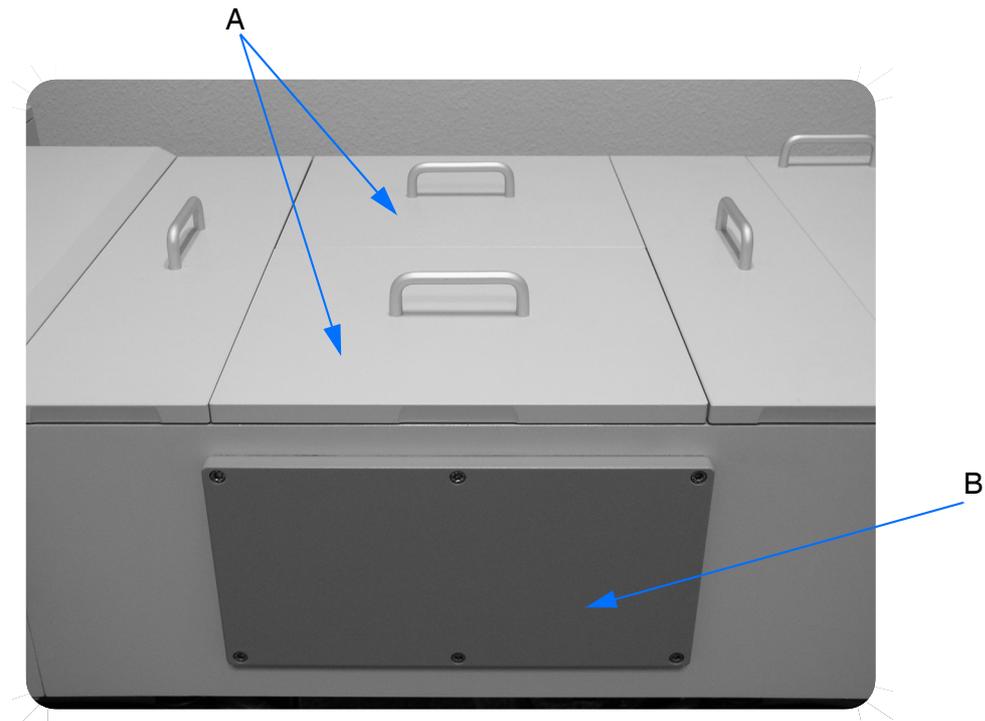


Figure 15: IFS 125HR - Sample compartments, exterior view

Flaps isolate the sample compartment to preserve vacuum in the remaining optics unit when changing the sample or installing the accessory.

The sample compartment can be accessed by lifting the top lid (A in figure 15) or removing the cover plate (B in figure 15) at the sample compartment front if you have large accessories to be installed.

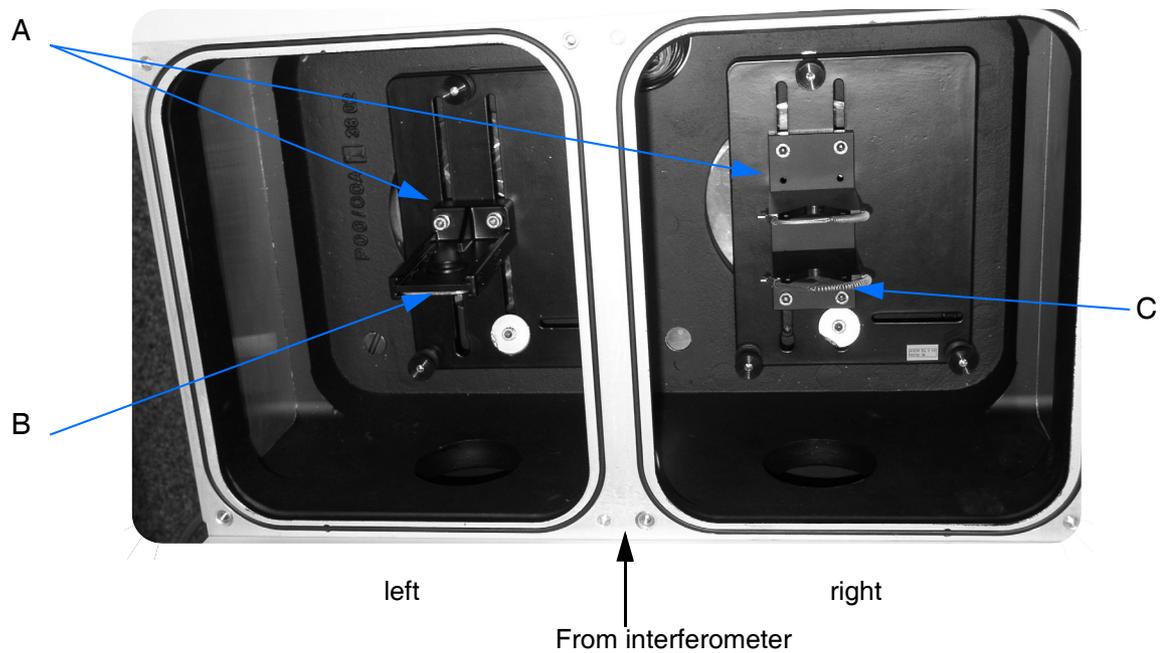


Figure 16: IFS 125HR - Sample compartment, interior view

	Definition
A	Extra large baseplate
B	Sample holder (2" x 3")
C	Holder for gas cell (up to 20cm)

## Quick Lock™ Base Plate

The sample compartment can optionally be equipped with the Quick Lock™ mechanism for positioning and locking different measurement accessories, e.g. gas cells. This mechanism provides a solid lock even for heavy and bulky accessories and allows a quick, easy and reproducible positioning of the measurement accessory. For further details, see chapter 5.

## Sample Options

### Sample Well

IFS 125HR can also be configured with a vacuum sample well which enables the use of accessories under ambient pressure with evacuated spectrometer optics. The sample well has exchangeable windows.

### Sample Holder

Bruker accessories which need to be inserted into the sample compartment are either pre-mounted on a base plate or can be mounted on one of the sample holders (B or C in figure 16) available for the extra large base plate (A in figure 16). The base plate is supported by three adjustable height screws. Thus, the base plate height and angle can easily be adjusted. For further details, see chapter 5.

## Sample Compartment Isolation Device

Flaps or optional windows are used to permit the isolation of the sample compartment from adjacent compartments. These isolation devices facilitate the insertion and removal of the sample as the sample compartment is separately vented or evacuated. For further details, see chapter 5.

## CHANNEL SWITCHING SUB-CHAMBER

IFS 125HR comprises 2 channel switching sub-chambers to direct the beam to the appropriate sample compartment which is located between these two channel switching sub-chambers.

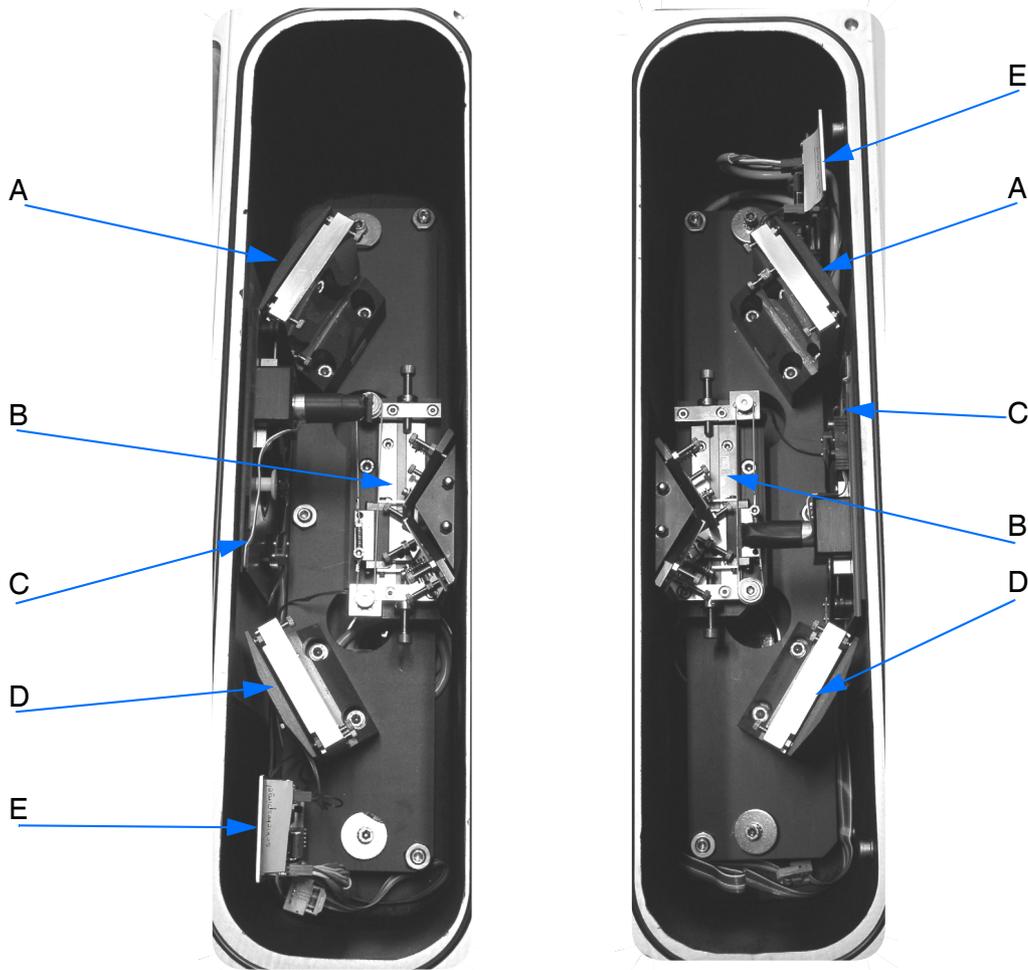


Figure 17: IFS 125HR - Channel converter compartments, interior view

	Definition
A	Toroidal focusing mirrors, left sample compartment
B	Beam switching units
C	Flaps
D	Toroidal focusing mirrors, right sample compartment
E	Motor driver (CAN bus interface)

The flaps can be equipped with windows (size: 35 x 5mm) to allow a signal check when the compartment is closed.

**Note:** A small shift of the focus position may occur due to the refraction at the windows.

## DETECTOR COMPARTMENT

The detector compartment can accommodate up to 4 internal and 2 external detectors. All 6 detector positions are accessible by beams from both sample chambers. Up to 4 liquid-nitrogen cooled or room temperature detectors equipped with the new DigiTect™ technology can be mounted inside the compartment. The DigiTect™ technology ensures a signal transmission free from interferences and guarantees the highest signal-to-noise ratio.

To operate room temperature detectors of the previous IFS 120HR design, an appropriate adapter can optionally be installed.

The external positions enable the connection of large liquid-helium cooled detectors such as FIR bolometers or other detectors with large dewars.

For emission work a separate detector chamber can be mounted at the collimated beam exit port (I in figure 4) of the interferometer to maximize energy throughput in the NIR/VIS/UV range.

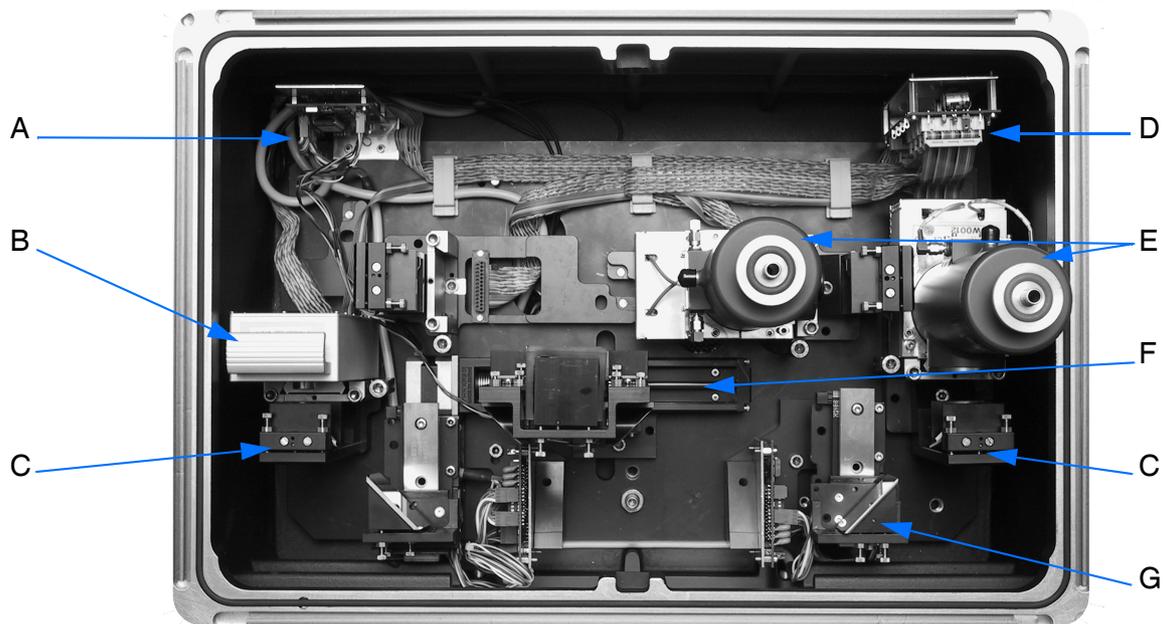


Figure 18: IFS 125HR - Detector compartment, interior view

	Definition
A	Stepper motor driver (CAN bus interface)
B	Room temperature detector (DigiTect™)
C	Focusing mirrors
D	Digital detector signal multiplexer
E	Liquid-nitrogen cooled detectors
F	Beam-switching unit for detector position 1/2, 3/4 and 5/6
G	Beam-switching unit for detector position 1 and 2

In the standard configuration IFS 125HR is equipped with a liquid N<sub>2</sub>-cooled MCT detector system for MIR spectral range and high spectral sensitivity.

Apart from the standard detector there is a large number of optional detectors available. All detectors are mounted on dovetail slides which allow an easy interchange. For a list of detectors available, see appendix B.

## Detector Outlet Ports

There are two detector outlet ports which allow to connect external detectors with large dewars, e.g. a bolometer (see figure 19 on the right). A 1:1 image of the input aperture is provided at the external focus position.

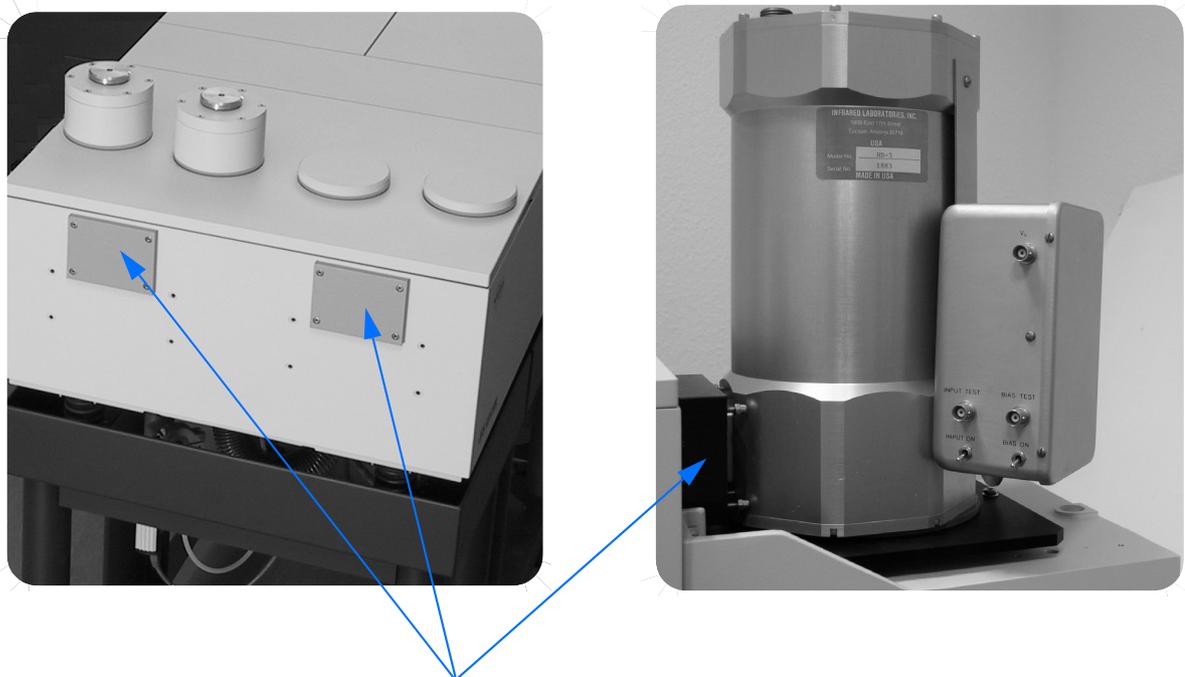


Figure 19: IFS 125HR - Detector outlet ports

## Detector Types

Detector	Spectral Range (cm <sup>-1</sup> )	Operating Temperature
<b>MIR</b>		
DLATGS	12,000 - 370	Room temperature cooled
MCT narrow band	5,000 - 780	Liquid-nitrogen cooled
MCT mid band	12,000 - 600	Liquid-nitrogen cooled
MCT broad band	12,000 - 420	Liquid-nitrogen cooled
<b>NIR</b>		
InSb	9,600 - 1,850	Liquid-nitrogen cooled
InGaAs	12,800 - 5,800	Room temperature cooled
InGaAs	12,800 - 4,000	Room temperature
Ge diode	12,800 - 5,500	Room temperature
<b>FIR</b>		
Si bolometer	40 - 5	Liquid-helium cooled
Si bolometer	370 - 10	Liquid-helium cooled
DLATGS	700 - 10	Room temperature cooled
<b>VIS</b>		
Si diode	25,000 - 9,000	Room temperature cooled

**Caution:** The windows of some detectors (MCTs) are made of harmful or (very) toxic material. However, during normal spectrometer operation this material is considered not to impose any health hazard.



**Caution:** If the windows break caused by mechanical effects or thermal shock, handle the window fragments with utmost care as they involve harmful or toxic substances which may cause personal injury when inhaled or swallowed. Avoid any skin or eye contact. Always observe the safety data sheets provided with the windows.



## VACUUM SAFETY

---

IFS 125HR uses a rotary vacuum pump. There are safety regulations to be observed when using such kind of pump. In general, the safety instructions are described in more detail in the documentation provided by the pump manufacturer. Carefully read this documentation before you operate and repair the pump, or perform any maintenance procedures.

- Many vacuum pump oils are flammable. Store and handle them with care.
- Oil spills are slippery. Completely absorb any spill by an appropriate material (cloth) and immediately dispose it to prevent accidents.
- Make sure that there is sufficient ventilation around the pump to prevent the pump from overheating. If operated in hot environments, additional pump cooling may be required to prevent the pump from exceeding its maximum operating temperature.
- Check the oil level weekly and add oil if needed to prevent the pump from overheating or seizing up.
- Compare the pump oil color with fresh oil on a regular basis. Significant color differences may indicate serious contamination or any other kind of oil deterioration. Remove the used oil from the pump and fill in fresh oil. Always dispose off used oil in an ecologically sensitive way.

### Venting Vacuum Pump Exhaust

Routine operation of a mechanical roughing pump generates a fine mist of oil droplets in the pump exhaust. Mist generation can be massive if the pump operates when:

- there is a serious leak in the hose connecting the pump to IFS 125HR.
- pumping is performed **without** all lids in place (and seated properly).
- there is a significant leak in the spectrometer.

The mist can be a source of contamination as well as a health hazard. We recommend to connect the roughing pump exhaust directly to a demisting filter and vent to the outside air using at least a 25mm inside diameter tube. If the piping to the outside is longer than 3m (10ft.), the exhaust piping inside diameter should be at least 40mm (1.5in.).

**Note:** If you regularly use the demisting filters, they will gradually become saturated with oil and decrease in their performance. The filter elements must then be replaced. Refer to the documentation supplied with the demisting filters.

# OPTICAL PATH

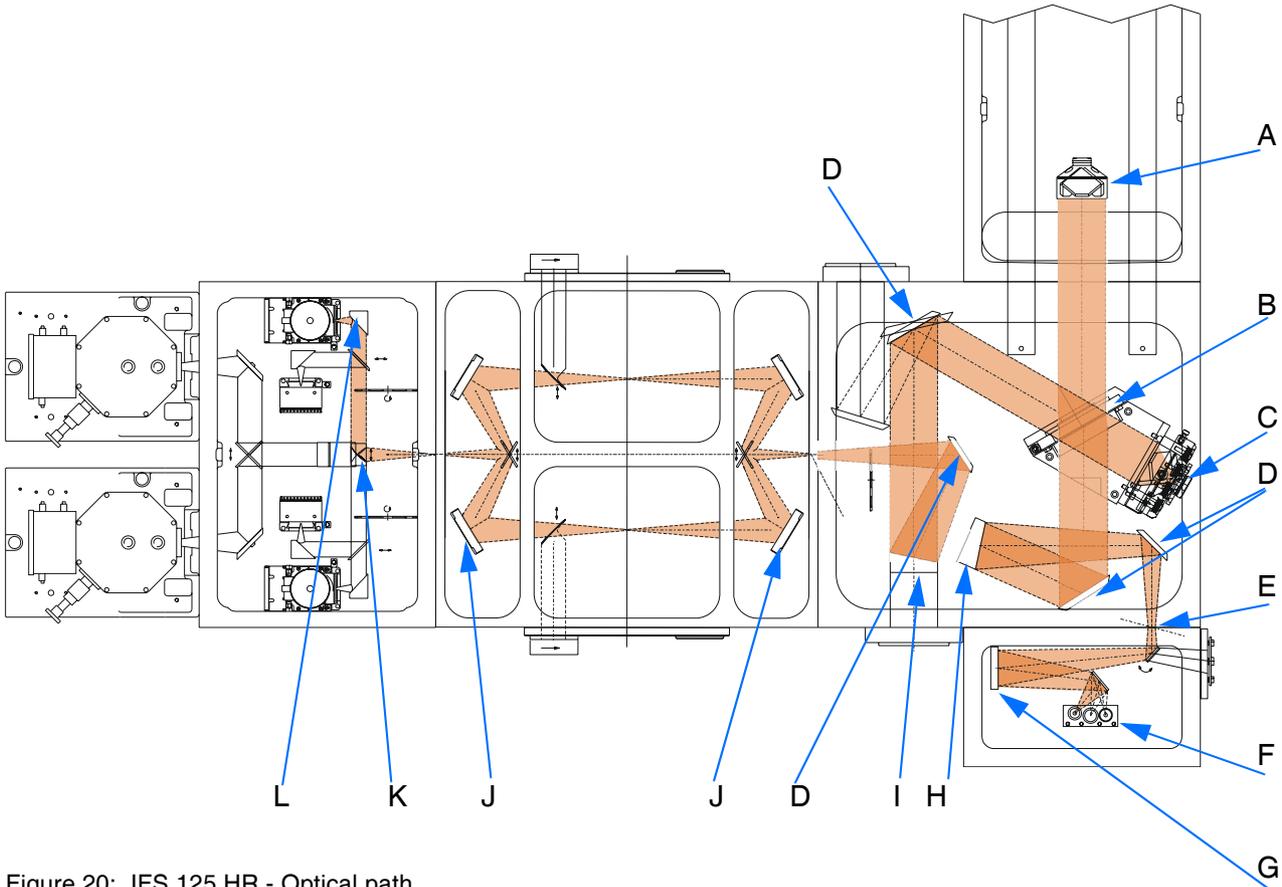


Figure 20: IFS 125 HR - Optical path

	Definition
A	Scanner with movable retroreflecting mirror
B	Beam splitter
C	Fixed retroreflecting mirror
D	Folding mirror
E	Input aperture (field stop)
F	Sources
G	Spherical mirror
H	Collimating parabolic mirror
I	Focusing parabolic mirror
J	Toroidal mirror
K	Collimating parabolic mirror
L	Focusing parabolic mirror



# SPECTROMETER OPERATION

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If IFS 125HR has been configured and connected to the power supply and PC, the spectrometer is ready to operate. The IFS 125HR spectrometer is completely software controlled, i.e. many spectrometer components (e.g. light source, detector) are selected and controlled by using the OPUS™ software.

This chapter describes the spectrometer-related aspects of spectroscopic measurements. For information on software-related aspects (e.g. parameter setting and data acquisition), refer to the OPUS™ software reference manual. The OPUS™ *Getting Started* manual explains step by step how to perform the first measurement after the spectrometer has been set up.

## SWITCHING THE SPECTROMETER ON AND OFF

---

The spectrometer is turned on and off by the main power switch (see N in figure 71 on page 156). After powering up IFS 125HR the spectrometer starts booting. After a few seconds the SR LED (see L in figure 67 on page 147) turns red and the spectrometer beeps which indicates that booting is in progress now. Booting and initializing will take about 90 seconds. The spectrometer beeps again and the SR LED turns from continuous red to sporadic flashing red if the self-test has been performed successfully.

**Note:** Wait at least 25 minutes before running any measurements after powering up the spectrometer. This allows the electronics and the laser to stabilize.

After about 25 minutes the HeNe laser has stabilized. The spectrometer beeps and the HeNe LASER LED (I in figure 71) lights continuously. Open the *Control Panel* tab by means of the *Optic Setup and Service* command from the OPUS™ *Measure* menu. Scroll to the *Scanner control* item. Click once on *Reinit Scanner*. After a while the FWD and TKD LEDs (B and C in figure 67) will rhythmically flash, indicating that the scanner is in short scan mode.

## QUICKLOCK™

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If you insert and lock a QuickLock™ accessory, all connections are established and the accessory is automatically identified by the OPUS™ application software, more precisely by the AAR software (Automatic Accessory Recognition). In addition, the recommended measurement parameters are selected automatically.

### To insert accessories by using a QuickLock™ baseplate proceed as follows:

- 1 Hold the accessory with the QuickLock™ baseplate, with the baseplate front edge slightly tilted upwards. Then, gently press the electrical baseplate connectors against their counterpart of the QuickLock™ holder. Put the baseplate down. Ensure that the baseplate is horizontally aligned to the QuickLock™ holder.
- 2 Gently apply downward pressure to the front edge of the baseplate until the baseplate snaps into its correct position.

### To remove accessories by using a QuickLock™ baseplate proceed as follows:

- 1 Push the QuickLock™ release lever backwards.
- 2 While pushing the QuickLock™ release lever, lift the front edge of the QuickLock™ baseplate until the baseplate snaps free.
- 3 Carefully lift the baseplate off the QuickLock™ holder. Be careful to avoid damage to the electrical connectors at the baseplate rear side.

## AUTOMATIC ACCESSORY RECOGNITION

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As soon as the accessory is locked into the QuickLock™ holder, the AAR software (Automatic Accessory Recognition) starts and automatically identifies the particular accessory for sample measurement, provided you have activated the AAR command in the OPUS™ software.

AAR performs several tests, adapts the sample measurement parameters and opens the OPUS™ *Measure* menu to start the sample measurement. The test sequences and sample measurement parameter settings are defined in the *ADF.dat* accessory definition file.

For any further information on how to activate AAR, refer to the OPUS™ AAR manual.

**Note:** If your accessory has not yet been registered, you will be asked to do so. For detailed information on how to register a new accessory, see the OPUS™ AAR manual.

## CHANGING BEAM SPLITTER

The basic spectrometer configuration is equipped with an MIR beam splitter, i.e. KBr substrate with multilayer coating.

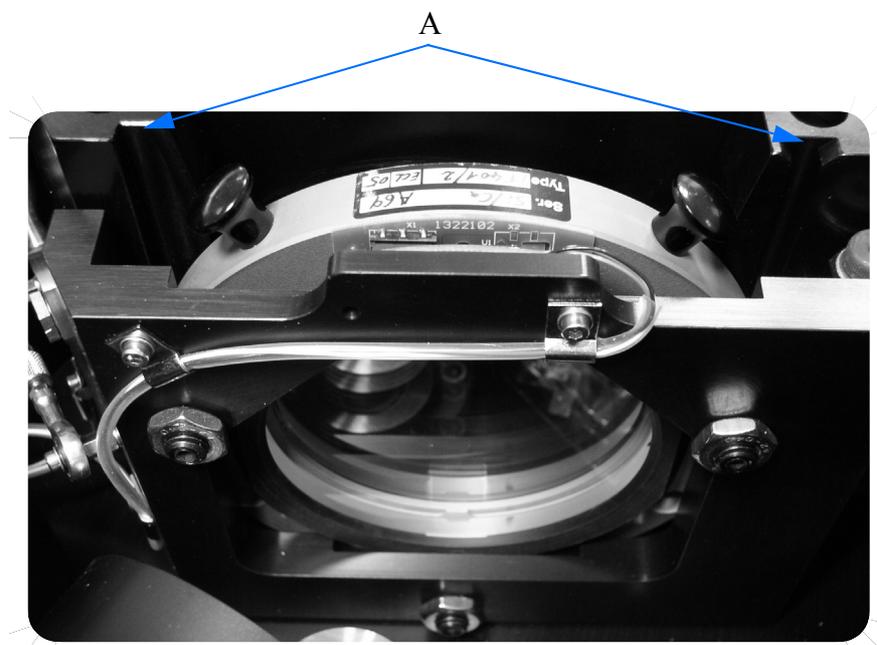


Figure 21: IFS 125HR - Beam splitter located in interferometer compartment

All beam splitters available for IFS 125HR are electronically coded, enabling the spectrometer firmware to auto-detect the beam splitter type currently installed. The data about the beam splitter type are transferred to the OPUS™ application software, which in turn selects the appropriate parameter set for the measurement.

**Caution:** The beam splitter is a very susceptible to external influences. Handle the beam splitter with utmost care and observe the following operating instructions to ensure a long service life.



### Operating Instructions

- Do not touch the beam splitter surface. Consequently, the beam splitter may become useless. Always hold the beam splitter on the two knobs (A in figure 22).

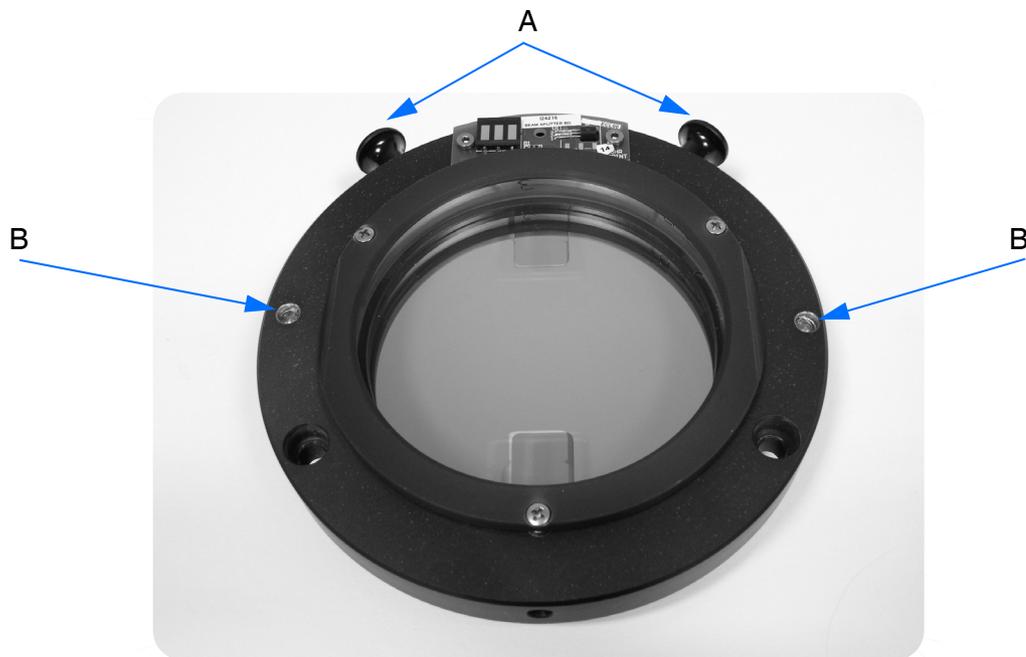


Figure 22: Beam splitter

- Some beam splitter material is hygroscopic. Never expose this material to humidity, water or aqueous solutions. Always store the beam splitter in a dry and sealed container, e.g. in the beam splitter storage box, and fix the protective covers onto the beam splitter (see figure 23).



Figure 23: Beam splitter with protective cover

- Do not try to loosen or fasten the screws as this will impair the optical quality of the beam splitter.
- Do not try to clean the beam splitter.
- Do not expose the beam splitter (especially beam splitters made of KBr) to large temperature changes. **In particular, a cold KBr beam splitter must not be exposed to a warmer ambience, as this will lead to condensation of humidity.**

If the measurement requires a different spectral range, you can change the beam splitter. Changing the beam splitter is easy as a locking mechanism automatically fixes the beam splitter at its pre-aligned position, as soon as you move the release lever (A in figure 24) into the locked position (down).

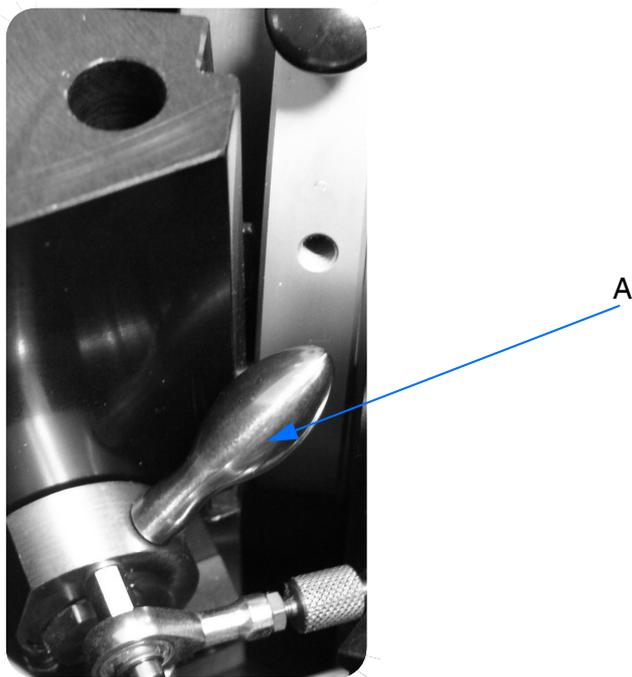


Figure 24: IFS 125HR - Beam splitter release lever

## To change the beam splitter proceed as follows:

- 1 Vent the spectrometer, if it is not yet at ambient pressure.

**Note:** If you change the beam splitter frequently, venting the spectrometer with dry air or nitrogen is highly recommended to reduce the air humidity level inside the interferometer compartment. Dry-air venting will considerably reduce the spectrometer down-time after changing the beam splitter.

- 2 To get access to the beam splitter first remove the beam splitter lid. Unlock the lid by turning the 2 locks of the interferometer compartment to the open position as displayed in figure 25. Take off the lid.



Figure 25: Interferometer compartment lock in open position



**Caution:** When opening the lid there is the risk of exposure to laser light as the laser beam can emerge from the opening. Do not stare into the beam. Direct exposure to laser radiation can lead to permanent eye damage.

- 3 Move the release lever (figure 24) into the unlocked position (i.e. further up towards your direction).
- 4 Carefully remove the beam splitter straight upwards without catching an edge. Hold the beam splitter - with two hands - on the knobs. **Make sure that the 3 contact springs (A in figure 26) at the locking door (B) do not touch the beam splitter surface!**
- 5 Store the beam splitter in a dry storage box.



Figure 26: IFS 125HR - Changing beam splitter

- 6** Insert the new beam splitter with the electrical contacts facing to the scanner side. Hold the beam splitter - with two hands - on the knobs.
- 7** Align the two guiding pins (B in figure 22) with the slots (C in figure 26 and A in figure 23) in the block.
- 8** Push down the beam splitter completely, until you feel resistance.
- 9** Move the release lever into the locked position (i.e. further down from your direction).
- 10** Make sure that the contact springs match the corresponding contact areas of the beam splitter. The spectrometer beeps when it detects the new beam splitter and automatically starts scanning.

- 11 Close the lid and lock it by turning the interferometer compartment locks to the closed position as displayed in figure 27.



Figure 27: Interferometer compartment lock in closed position

- 12 Check whether a signal is detected and the optics works correctly. For detailed information, refer to the OPUS™ Reference Manual.

## CHANGING DETECTOR

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The basic spectrometer configuration is equipped with a liquid N<sub>2</sub>-cooled MCT detector. If the measurement requires a different spectral range or different detector sensitivity, you can install a second detector or exchange the installed DigiTect™ detector for another DigiTect™ detector, such as Insb or NIR detectors with a higher sensitivity. For further details on the different detector types, see the table in chapter 4.

A removable lid provides access to the detector compartment. The dovetail detector mounting facilitates the exchange, a re-alignment is not necessary<sup>1</sup>. All detectors available for IFS 125HR are electronically coded, enabling the spectrometer firmware to auto-detect the detector type currently installed. The data about the detector type are transferred to the OPUS™ application software.

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1. Sometimes a minor realignment of the last mirror in front of the detector is required to optimize the signal.

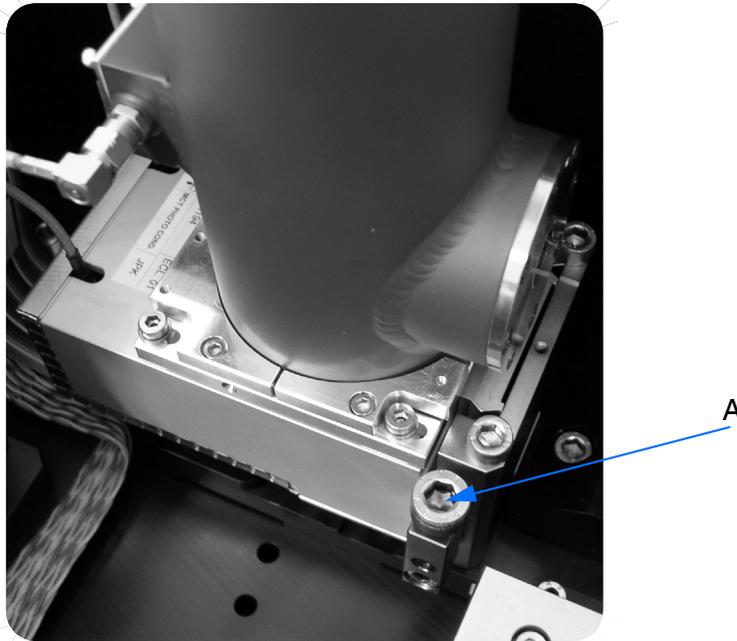


Figure 28: IFS 125HR - Detector mounted

### To change the detector proceed as follows:

- 1 Completely loosen the counter nuts (A in figure 29) from all detectors. Liquid-nitrogen cooled detectors only are equipped with such counter nuts.

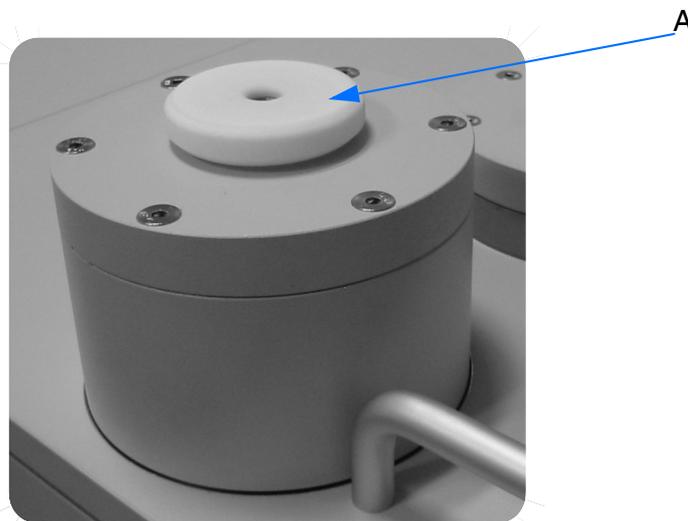


Figure 29: Counter nut on detector

- 2 To get access to the detector compartment remove the detector compartment lid.
- 3 Loosen the M6 allen locking screw (A in figure 28) that secures the detector, by using a hex wrench. Depending on which detector you want to remove, the allen screw is on the left or right side of the detector.
- 4 Pull the detector straight upwards out of the dovetail guide by gently tilting it to the left and right.



**Caution:** Remove the detector with utmost care to avoid any damage on the mirrors next to the detector. When removing or inserting a detector at position 1 or 4 make sure that the SMA connector does not get caught at the O-ring flange of the compartment wall.

- 5 Insert the new detector precisely into the dovetail guide and push the detector downwards until it locks into place. A beep indicates that the electrical connections have been established.

**Note:** The electrical connections are established automatically if the detector has been completely pressed down.

- 6 Fasten the allen screw by using a hex wrench.
- 7 Check whether a signal is detected<sup>1</sup> and the optics works correctly. For detailed information, refer to the OPUS™ reference manual.
- 8 The detector signal may be optimized by slightly adjusting the last parabolic mirror in front of the detector.
- 9 Screw the bellows (C in figure 31) onto the detector as displayed in figure 30.

---

1. If applicable, the detector has to be cooled at first (see below).



Figure 30: Bellows mounted on detector

- 10 Put the lid on the detector compartment again. Manually tighten the counter nuts on all liquid-nitrogen cooled detectors.

## COOLING DETECTOR

To ensure operating ability, cryogenic detectors (e.g. MCT detectors) have to be regularly cooled by using liquid nitrogen.

**Warning:** Always handle liquid nitrogen with utmost care. The temperature of liquid nitrogen is minus 196°C (minus 320.8°F). Due to this extremely low temperature, any skin contact can cause severe frostbites!



Even the gases escaping from the liquid nitrogen are extremely cold and can cause frostbites. The sensitive eye tissue can be damaged if exposed to this cold gas, even if exposed for a short period of time. Always protect your eyes by wearing a face shield or safety goggles! Make sure that the goggles include side shields to provide adequate protection!

**Caution:** High nitrogen gas concentrations used in non-ventilated rooms cause asphyxiation! Use liquid nitrogen only in well-ventilated rooms. Nitrogen gas is colorless, odorless and tasteless. Therefore, it cannot be detected by human senses and will be inhaled as if it were normal air.



## To cool the detector proceed as follows:

To cool the detector, while the spectrometer is under vacuum, use the bellows gasket supplied with the spectrometer. This kind of gasket consists of the following components:

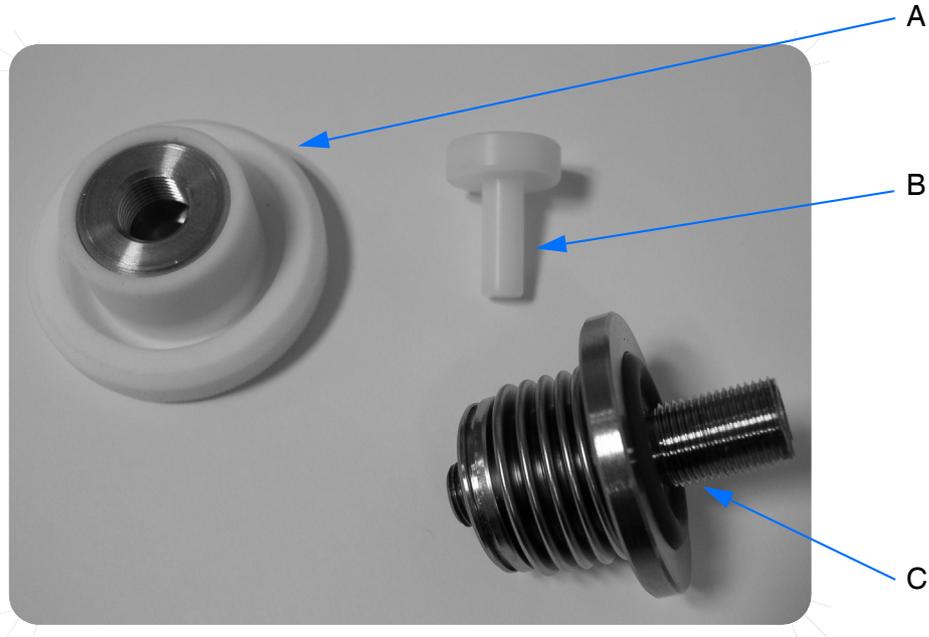


Figure 31: Bellow gasket components

	Definition
A	Counter nut
B	Plug
C	Bellows, including 2 O-rings (11.00 x 3.00, 18.00 x 5.00)

- 1 Make sure that the bellows and counter nut have been installed as described in the previous section. *Only when aligning a detector at ambient pressure may you work without the bellow gasket components and insert the funnel directly into the dewar.*
- 2 Insert the supplied funnel into the detector filling port (figure 32) and slowly fill in liquid nitrogen. At the beginning the liquid nitrogen will evaporate and escape.



Figure 32: IFS 125HR - Cooling the detector

**Warning: Liquid nitrogen boils and splashes when it is filled into a warm container. Therefore, fill in the liquid nitrogen slowly to avoid boiling and splashing. Keep away from boiling and splashing liquid nitrogen and its escaping cold gas.**



- 3 Wait until the funnel is empty before refilling. If the liquid nitrogen does not escape any more, the dewar has cooled down to the liquid nitrogen temperature. Just before this happens very often a sudden blast of nitrogen escapes from the dewar. Fill the funnel again with liquid nitrogen. Avoid spilling too much liquid on the housing.
- 4 Repeat this procedure until the detector dewar has been filled to maximum. (As a rule of thumb for the standard MCT detector: the maximum dewar capacity is about the quantity of 3 funnel fillings. Note that the first 3 funnel fillings will evaporate almost completely.) Avoid overfilling as the liquid would then flow out of the filling port. Take off the funnel and insert the plug (B in figure 31).
- 5 Wait about 15 minutes before starting the measurement to allow the detector to stabilize. Meanwhile you may observe the signal by means of the *Check Signal* tab from the Advanced Measurement command in the OPUS™ *Measure* menu.

**Note:** The typical hold time depends on the detector. There are liquid nitrogen detectors which have a hold time of 8, 12 or 24 hours.

## EVACUATING AND VENTING SPECTROMETER

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Venting by using dry air is recommended if you frequently open the compartment lids, e.g. to change different components, or if the ambient air humidity level is high. Such dry venting procedure reduces the level of water vapor inside the spectrometer. Thus, subsequent evacuation of the spectrometer proceeds much faster.

**Note:** Water vapor, CO<sub>2</sub> and other atmospheric gases cause unwanted absorptions in the infrared spectrum range. Therefore, open the sample, detector and/or interferometer compartments only if necessary in order to prevent water vapor or other gases from entering these compartments and adhering to the walls.

Vent the spectrometer by using a gas supply according to the following venting conditions:

- Dry (dew point < -40°C), oil-free and dust-free air or nitrogen gas
- Maximum pressure of 1800hPa
- Sustained venting gas flow rate should be at least 1l/s



**Danger:** Do not use flammable gases for venting the spectrometer. Some spectrometer components become very hot during operation. If flammable gases come in contact with hot components there will be the risk of fire and/or explosion!

For information on how to connect the spectrometer to a venting gas supply line, refer to chapter 3.

### Evacuating



**Caution:** Do not leave any objects inside the spectrometer, which contain large amounts of water, e.g. pieces of wood. The escaping water may destroy sensitive components, e.g. KBr beam splitter. The same applies to escaping liquid nitrogen from a detector dewar with its bellows not being fixed!

- Check whether the liquid nitrogen detectors have their bellows fixed, and the dewar counter nuts are firmly tightened.
- Make sure that all compartments are closed by their lids.

- Terminate any measurement.
- Select the *Optic Setup and Service* command from the OPUS™ *Measure* menu. Click on the *Control Panel* tab<sup>1</sup>. Scroll to the *Vacuum Control Commands*.
- Click once on *Evacuate instrument*. The pump will be switched on automatically<sup>2</sup> and a few seconds later the evacuation valve will open.
- The scanner will stop automatically, if the corresponding bit is set in the beam splitter currently inserted.
- If the pressure reaches the 1hPa threshold, the scanner will automatically be re-initialized, and you can continue to measure.
- For high precision measurements it is recommended to wait approximately 1h to let the instrument stabilize again. During this period the intended source must be switched on, e.g. by using the OPUS™ *Check Signal* tab.

**Note:** If the 1hPa pressure threshold is not reached within a few minutes, vent the instrument again and search for the leak (see chapter 7).

## Venting Sample Compartment

The sample compartment can be vented separately, which allows quick access.

- Terminate any measurement.
- Select the *Optic Setup and Service* command from the OPUS™ *Measure* menu. Click on the *Control Panel* tab<sup>1</sup>. Scroll down to the *Vacuum Control Commands*.
- Click once on *Vent sample compartment*.
- If the compartment has reached ambient pressure, you can remove its lids.

**Note:** You will not be able to check the signal while the flaps are closed, unless there are windows in the flaps.

---

1. Alternatively, you may access the instrument by the WEB interface, see chapter 8.

2. This requires a correctly-installed starter unit for the vacuum pump. Otherwise, switch on the vacuum pump manually before you evacuate the instrument.

## Evacuating Sample Compartment

The sample compartment can be evacuated separately if it had been vented before. **However, it is not possible to evacuate it separately while the interferometer is at ambient pressure!**

- Make sure that all compartments are closed by their lids.
- Terminate any measurement.
- Select the *Optic Setup and Service* command from the OPUS™ *Measure* menu. Click on the *Control Panel* tab<sup>1</sup>. Scroll to the *Vacuum Control Commands*.
- Click once on *Evacuate sample compartment*.
- If the differential pressure is low enough, the flaps are opened automatically.

## Venting Spectrometer

- Terminate any measurement.
- Select the *Optic Setup and Service* command from the OPUS™ *Measure* menu. Click on the *Control Panel* tab<sup>1</sup>. Scroll down to the *Vacuum Control Commands*.
- Click once on *Vent instrument*.
- The scanner will stop automatically if the corresponding bit is set in the beam splitter currently inserted.
- If the instrument has reached ambient pressure, the scanner will automatically be re-initialized, and you can continue to measure.
- Now, you can open the lids.

## Standby

If the instrument is not to be operated for a longer time, it is recommended to evacuate it and switch it into *Standby*, i.e. all valves are closed.

- Select the *Optic Setup and Service* command from the OPUS™ *Measure* menu. Click on the *Control Panel* tab<sup>1</sup>. Scroll down to the *Vacuum Control Commands*.
- Click once on *Standby*.
- All valves will be closed and the pump is switched off.

---

1. Alternatively, you may access the instrument by the WEB interface, see chapter 8.

# MAINTENANCE

---

To a large extent IFS 125HR can be maintained by the operator himself, i.e. the operator can replace components with a limited service life (e.g. IR source) without requiring the assistance of the Bruker service personnel. The following maintenance procedures are described in this chapter:

- Checking laser signals
- Replacing sources
- Source cooling system
- Replacing fuses
- Replacing windows
- Evacuating detector
- Vacuum system
- Cleaning rods

## GENERAL MAINTENANCE CONSIDERATIONS

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Perform only the maintenance procedures described in this chapter. Strictly observe the relevant safety precautions. Any failure to do so may cause property damage or personal injury. In this particular case Bruker does not assume any liability. Maintenance procedures not described in this manual should only be performed by a Bruker service engineer. For service assistance, see appendix I.

The following precautions must be observed to ensure the user and spectrometer safety:

- Disconnect the power cord before performing any maintenance procedures.
- Be careful if spectrometer covers are removed and the spectrometer is switched on to avoid looking into the radiation emitted by laser or sources, and contacting potentially harmful voltages.

**Caution: Avoid static discharge to prevent sensitive electronic components from being damaged.**



In general, electronic components, especially semiconductor chips, are very susceptible to static discharges caused by the operator. Even static discharge not perceptible to the operator can damage semiconductor chips. Therefore, it is important that the operator is

grounded to the spectrometer housing before any electronic component is touched inside the spectrometer.

Electrical grounding can be accomplished by

- using a grounding wrist strap (not supplied) or
- touching the a grounded object (e.g. radiator).

The grounding wrist strap is the most effective and preferred grounding method.

## CHECKING LASER SIGNALS

For reliable scanning and correct determination of the optical path difference it is very important to have proper laser signals at laser A and laser B detectors. The signals should be checked once a month.

### Amplitude

The amplitude of the two modulated signals must be in the range between  $-2V_{pp}$  to  $18V_{pp}$ . In addition, the absolute value of both signals must be in the range  $\pm 10.0V_{DC}$ . Any signal above or below will be distorted or clipped, leading to wrong detection of the laser zero crossings. When severely clipped, two or more zero crossings may be detected and scanning becomes impossible.

Connect a dual channel oscilloscope to the test adapter (see figure 71 on page 156). If the peak-to-peak amplitude (or the absolute value) is only close to or even out of specifications, check the following:

- 1 The laser beam must arrive properly at the two laser detectors. Normally, there is no re-adjustment required by the user.
- 2 The laser amplifier has two gain settings, which are selected by a corresponding bit in the EEPROM of the beam splitter. If the signal amplitude is too small and the low gain bit is set, you should write the high gain setting permanently into the beam splitter (and vice versa). See chapter 8 for details. **Note: After changing the gain setting the beam splitter locking door has to be opened once to make the change come into effect.**
- 3 If the signal for one beam splitter is too low (even with high gain setting) while the others have good signal, this particular beam splitter has to be replaced.
- 4 If the signal is too low for all beam splitters while the optical alignment is correct, the laser power itself may have dropped or one of the optical components in the laser beam may have been contaminated. Contact the local Bruker service.

## Signal Decrease Over Optical Path

The decrease of the peak-to-peak signal amplitude over the full optical path should be less than 35% (for systems with OPD > 700cm less than 40%).

Connect a dual channel oscilloscope to the test adapter (see figure 71 on page 156). Select the *Optic Setup and Service* command from the OPUS™ *Measure* menu. Click on the *Control Panel* tab<sup>1</sup>. Scroll to *Scanner Control*. Select *Fast adjust mode* to check the signal amplitude over the full path length. If there is to be a significant decrease towards the end, select *Back Short Adjust Mode* and wait until the scanner commutes around the end position.

Maximize the laser amplitude by means of the two screws at the deflecting prism (A in figure 33). Pay attention to the counter nuts.

**Note:** The adjustment is very sensitive. Do not apply any forces to the screws or their supporting brace and have all the covers closed (except for the interferometer compartment).

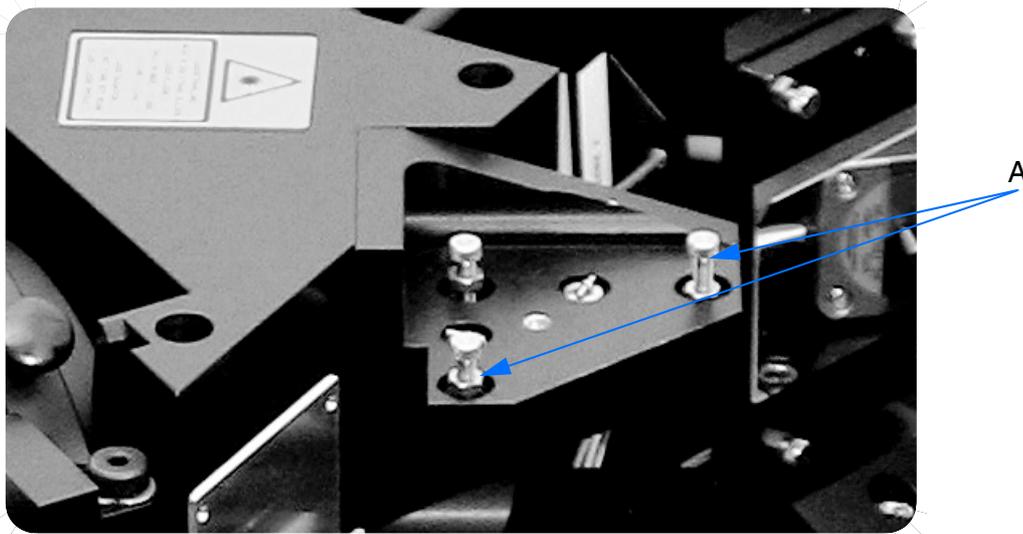


Figure 33: Adjusting screws at laser amplitude

## Phase

The phase between laser A and B signals should be  $90 \pm 45^\circ$ . Check in regular scanning mode with a dual channel oscilloscope connected to the test adapter. There is no way to adjust the phase, i.e. if the phase is out of specification, the particular beam splitter has to be replaced.

---

1. Alternatively, you may access the instrument by the WEB interface, see chapter 8.

## REPLACING SOURCES

The basic spectrometer configuration includes 1 MIR source, and optionally 1 NIR/VIS and 1 FIR. Replace a light source only if it is defective. The replacement procedure for all three types of light source is similar.



NIR/VIS



FIR



MIR

Figure 34: Sources used in IFS 125HR

The following table shows the estimated lifetimes of the sources used in IFS 125HR. It is recommended to have spare sources available when using sources with very short a lifetime. For details on sources available with Bruker refer to the current price list which can be requested on demand.

Source	Source Type	Estimated Lifetime (hours)
FIR	Hg lamp, water cooled	500
MIR	Globar, water cooled	5000
NIR	Tungsten lamp	2000
VIS	Tungsten lamp	50

Have the MIR source (global) always turned on to ensure a stable operating temperature. Continuous global operation does not seriously affect its lifetime. Other sources should only be turned on about 30 minutes before a data acquisition will be performed to give the source sufficient time to stabilize.

The sources are fixed by small springs in a source holder which is connected to a luster terminal as displayed in figure 35.

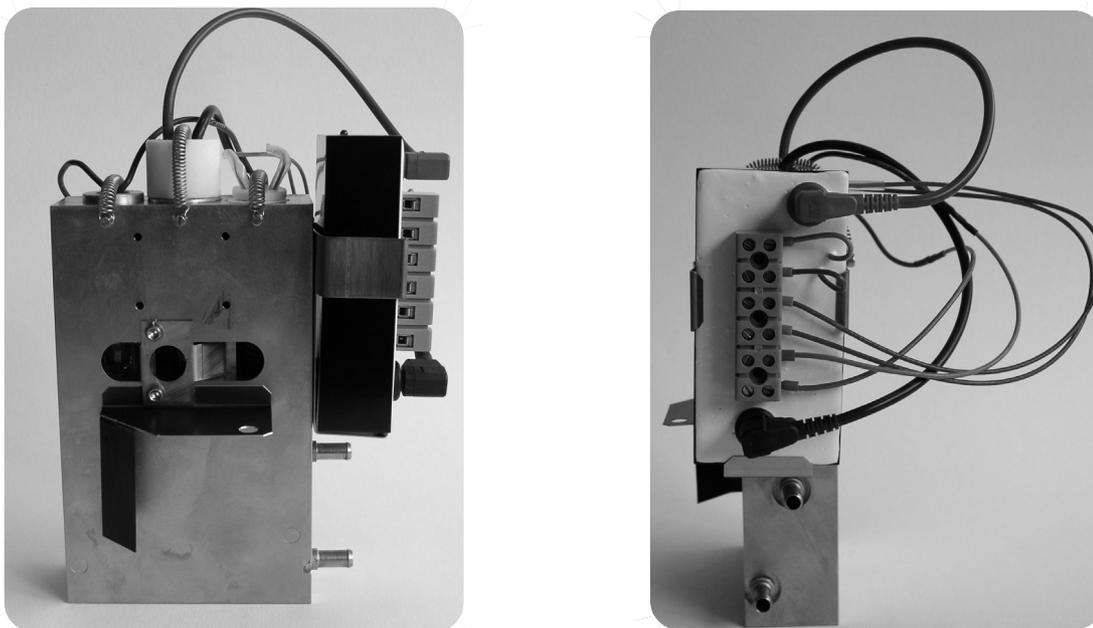


Figure 35: Source holder (left), luster terminal (right)

### To replace the sources proceed as follows:

- 1 Switch off the spectrometer.
- 2 To get access to the sources remove the source compartment lid.

**Caution:** During spectrometer operation the light sources become very hot. Avoid any skin contact. Risk of skin burn! Wait until the light sources have cooled down to room temperature before you replace them.



- 3 Disconnect the source to be replaced from the luster terminal.
- 4 Open the spring and carefully lift the source out of the holder.

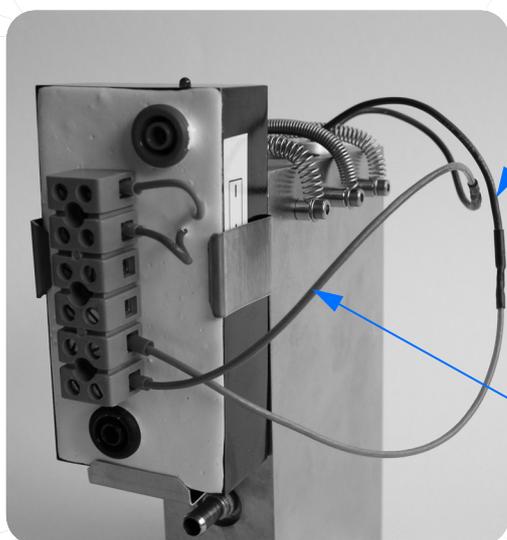
**Caution:** The global source is very brittle. Do neither knock against nor drop it.



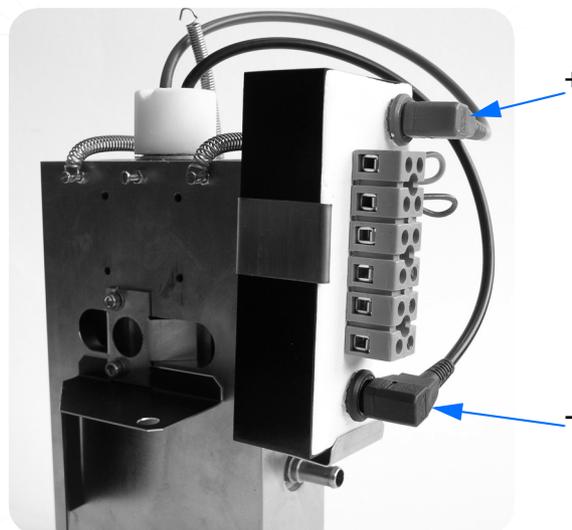
## 6 MAINTENANCE

### Replacing Sources

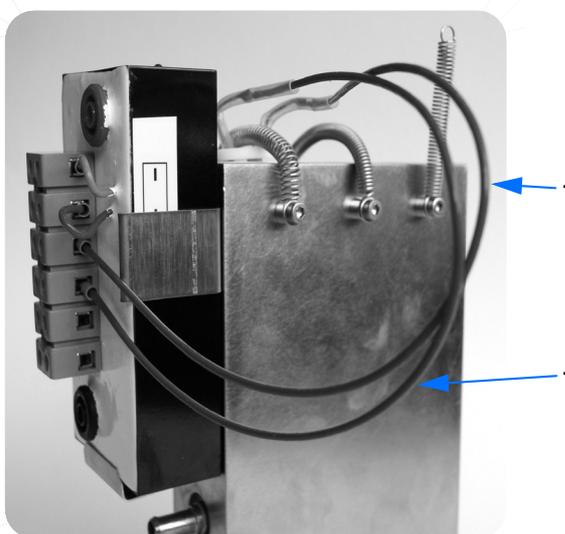
- 5 Insert the new source into the source holder and connect it to the inlet port of the luster terminal as displayed in figure 36. The red cable indicates plus, the blue cable minus. The black FIR cable also indicates minus.



NIR/VIS



FIR



MIR

Figure 36: IFS 125HR - Source connections to luster terminal

- 6 Close the source compartment lid.
- 7 Switch on the spectrometer.
- 8 Check whether a signal is detected and the optics works correctly using the OPUS™ software. For detailed information, refer to the OPUS™ Reference Manual.

**Note:** Make sure that you reset the source operating hour meter using the OPUS™ software<sup>1</sup>. Either click on the green status light (at the right end of the status bar) or select the *Optics Diagnostic* command in the *Measure* menu. The Instrument Status dialog opens. Click on the source icon and then on the *Service Info* button. The instrument Diagnostics opens. Click on the source *Reset* button. Close the HTML window by means of the OPUS™ browser.

## NIR/VIS Source

**Caution:** Do not touch the tungsten bulb of the NIR source with your fingers as this contaminates the bulb and significantly reduces the service life. Wear gloves when changing the bulb and observe the operating instructions indicated on the source packing.



- 1 Perform the steps 1 to 4 described above.
- 2 Pull out the bulb from the source holder. Always wear gloves.
- 3 Insert the new bulb into the source holder. Always wear gloves.
- 4 Continue with steps 5 to 8 described above.

**Caution:** The tungsten source used in IFS 125HR emits small amounts of UV radiation. However, if operated according to the safety instructions there is no danger of UV irradiation. Do not operate the NIR/VIS source outside the spectrometer.



The NIR/VIS source has only a small luminous area. Thus, it is recommended to realign the spherical mirror in the source compartment after the source has been replaced. Proceed as follows:

- 1 Select the *Advanced Measurement* command from the OPUS™ *Measure* menu. Click on the *Optic* tab and select *NIR* as source setting and *2.5mm* as aperture. Then, click on the *Check Signal* tab.
- 2 Look from the direction of the spherical mirror (G in figure 7 on page 20) onto the plane mirror in front of the input aperture. Try to see the image of the source on the aperture wheel. Wear sun glasses to avoid being glared.
- 3 Adjust the two screws set diagonally at the spherical mirror (G in figure 7 on page 20), with the image being centered around the aperture hole.
- 4 Maximize the intensity in *Check Signal* mode (use smaller aperture if necessary) by turning the source holder using pliers, and re-aligning the spherical mirror successively.

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1. Alternatively, you may use the WEB interface, see chapter 8.

## SOURCE COOLING SYSTEM

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The purpose of a source cooling system is to maintain a source at a stable temperature. The cooling system consists of:

- Water circulator
- Water pump
- Heat exchanger
- Fan

### Cooling System Failure

The most common causes of cooling system failures are:

- 1 No distilled water has been used and an accumulation of mineral deposits may be located on the water pump bearings. Use only distilled or de-ionized water which has an electrical conductivity of  $>18\text{M } \Omega$  to ensure safe operation and long component life. Even when using distilled water you have to replace the water every 6 months.
- 2 Air trapped in the pump impeller. Normally, the water pump is not self-priming which means that the pump flow can substantially be reduced (or stopped) if air is trapped in the pump impeller. It can be difficult to release the air. Keep water levels near maximum level and do not fully drain the pump unless the unit has to be disconnected and moved.
- 3 Insufficient cooling of water due to dust accumulating between the heat exchanger and the grid.
- 4 Water pump breakdown.

If the flow of cooling water is insufficient to cool the source, the thermo switch mounted on the source holder will cut the power to the source(s) to prevent the source(s) from being damaged.

### Preventive Maintenance

Performing the following procedures on a regular basis will extend the lifetime of the water pump:

#### Water Level

Check the water level in the water tank at least once a month. Keep the water level always at or just below the maximum indicator. Remove the cap and fill in distilled or de-ionized water, if required.

## Water Hose

Check the water hoses both inside and outside the spectrometer for possible leaks.

**Caution: Do not put the spectrometer into operation in case of any visible leakage of cooling water inside the source compartment! In case of non-observance this may cause severe damage to optical components, especially when evacuating.**



As the water pressure is not very high when operating the cooling system, leaks may possibly occur at a connector, e.g. a fitting or hose has become stressed or loose. If there are droplets around a hose connector, check for wear and resolve the situation. Either tighten the fitting or replace it.

## Air Intake Filter

Clean the heat exchanger air intake filter using a vacuum cleaner. When operating the cooling unit dust, lint and other contaminants can be sucked into and caught on the air intake filter. This could reduce the air flow used to cool the water in the cooling system. Clean the filter regularly (once a month) using a vacuum cleaner.

## Draining Cooling Water

This procedure has to be done every 6 months.

- 1 Turn off all sources.
- 2 Disconnect the power plug from the cooling unit socket.
- 3 Take off the hose from the cooling water inlet connection at the cooling unit.
- 4 Put the inlet hose end into a suitable empty container to drain the cooling water into this container.
- 5 Remove the reservoir cap. Raise the cooling unit above the sources level.
- 6 Turn on the cooling unit by reconnecting the power plug to the socket.
- 7 Fill distilled water into the reservoir at about the same rate as the hose fills the container.
- 8 Do not overfill. Watch the fill gauge on the cooling unit front.
- 9 If about 3.5l of water has been drained off, stop adding water to the reservoir and disconnect the power plug to stop pumping.
- 10 Immediately reconnect the cooling water inlet hose to the cooling water to avoid air bubbles in the line.
- 11 Pour away the water drained from the cooling unit.
- 12 Add enough distilled water to reach the maximum level on the cooling unit fill gauge.
- 13 Switch on the cooling unit and sources.
- 14 Replace reservoir cap on the unit.
- 15 Lower the cooling unit to its original position.

## Draining Water Circulator

Water acts as a lubricant between bearing surfaces. Bearing wear may increase if the circulator is running and the bearing is not fully moistened. The circulator has to be turned off as soon as the flow of water starts to break up (no longer a solid stream). This procedure has to be performed only if the cooling unit needs to be disconnected and moved. Air bubbles can be created in the water pump impeller if the unit is refilled, which could reduce or totally block circulation of water.

- 1 Turn off all sources.
- 2 Turn off the cooling unit. Disconnect the power plug from the socket.
- 3 Take off the hose of the inlet connection on the cooling unit.
- 4 Put the hose end into a suitable empty container.
- 5 Reconnect the power plug to its socket.
- 6 Monitor the water flow. As soon as the flow is no longer a continuous stream, disconnect the power plug immediately.
- 7 Disconnect the cooling water inlet hose from the circulator.

Blow air into the hose to force the remaining water being in the source lines and reservoir through the inlet hose to the container.

## REPLACING FUSES

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If the voltage status LEDs on the spectrometer electronic panel do not light, although the spectrometer is switched on assuming sufficient power is supplied to the instrument, the main power supply fuses may be blown.

### Main Fuses

The main fuses for the spectrometer are located below the main power supply switch of the spectrometer (A in figure 37). All fuses comply with IEC 60127-2.

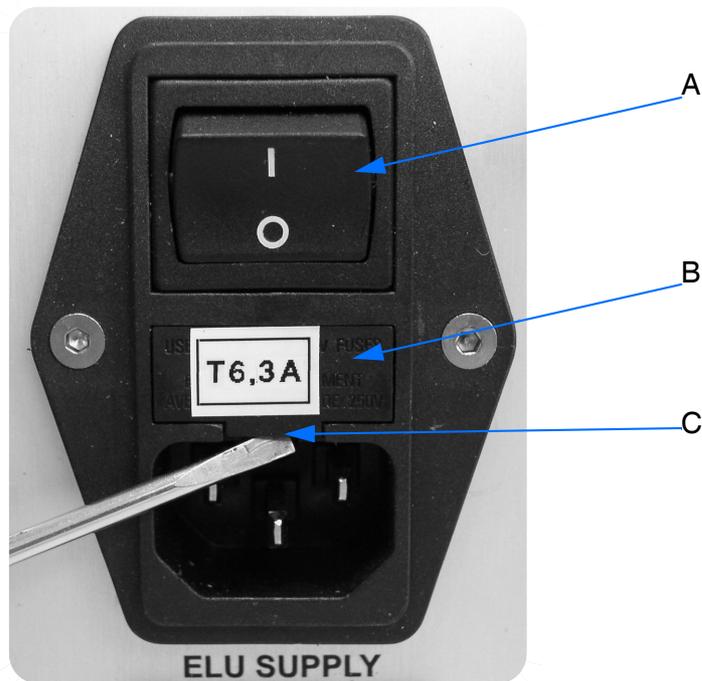


Figure 37: Fuse block

### To replace the main fuses proceed as follows:

- 1 Switch off the spectrometer by turning the main power switch (A) into the OFF position.
- 2 Unplug the spectrometer main power cable.
- 3 Pull out the fuse holder (B). Insert a small flat-ended screwdriver into the slot (C).
- 4 Gently raise the screwdriver to release the spring clip of the fuse holder.

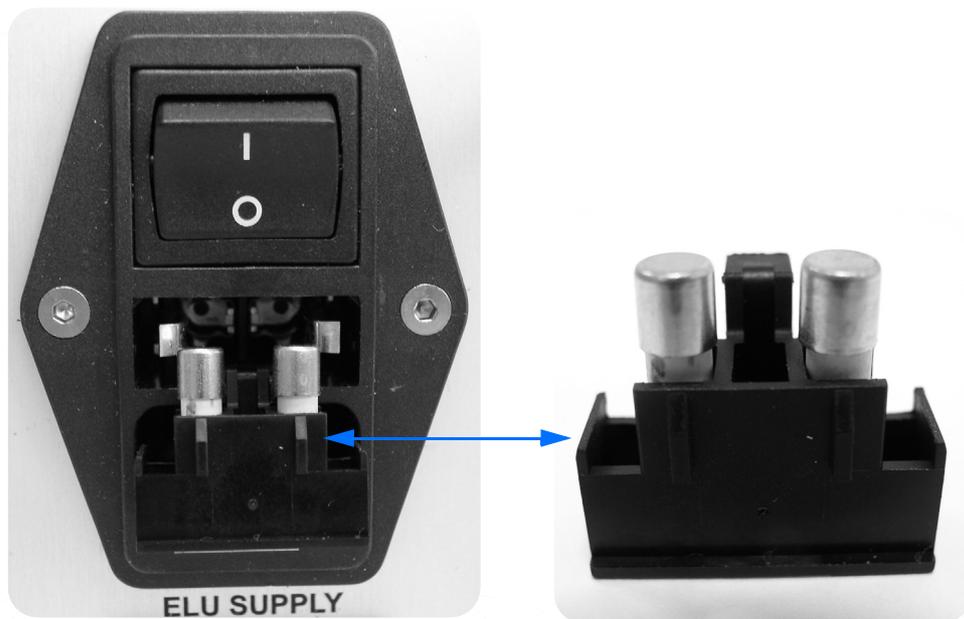


Figure 38: Open fuse holder

- 5 The fuse holder includes 2 fuses. Replace both fuses by 5x20mm fuses with a rating of 6.3AT, slow blow (according to IEC 60127-2), in the source control panel, and 4.0AT in the power supply panel, respectively.

**Note:** Recommended fuses are WICKMANN series 195, 6.3AT and 4.00AT respectively, WICKMANN order code 195 1630 002 respectively 195 1400 002 for a set of 10 fuses ([www.wickmannusa.com](http://www.wickmannusa.com)). Alternatively order single fuses at Bruker, Part No. 2258 (6.3AT) respectively 2257 (4AT).

- 6 Insert the fuse holder assembly back until the spring clip engages and the assembly is securely held.
- 7 Reconnect the main power cable to the spectrometer.
- 8 Switch on the spectrometer again.

## Fine-Wire Fuses

For specific components integrated in IFS 125HR, e.g. laser, source cooler, vacuum pump and valve supply, there are separate fine-wire fuses (5 x 20mm) which have to be replaced when blown. The fuses are located on the peripheral control panel, see figure 73.

## To replace the fine-wire fuses proceed as follows:

- 1 Switch off the spectrometer by turning the main power switch (A in figure 37) into the OFF position.
- 2 Unplug the spectrometer main power cable.
- 3 Use a flat-end screwdriver and insert it to the small fuse cap slot.



Figure 39: Fine-wire fuse

- 4 Gently press the fuse cap against the housing.
- 5 Quarter-turn the fuse cap counterclockwise.
- 6 Pull out the fuse from the housing.

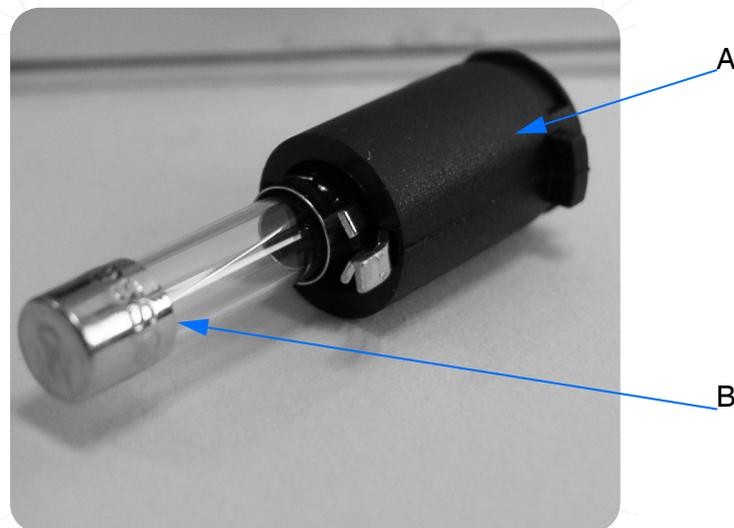


Figure 40: Bulb with fuse holder

- 7 Detach the bulb (B) from the fuse holder (A) and exchange it for a new one.
- 8 Insert the new fuse into the housing.
- 9 Quarter-turn the fuse cap clockwise.

## REPLACING WINDOWS

The appropriate window material for common wavelength ranges are shown below:

Wavelength Range	Window Material
MIR	KBr
NIR	Quartz or CaF <sub>2</sub>
FIR	Polyethylene



**Caution:** In case of KBr windows avoid any exposure to moisture as this may cause property damage.

The windows screwed on the interferometer compartment may need to be polished or replaced as they become dull. If you fail to polish the window, the throughput may seriously be reduced.

Figure 41 exemplifies the assembly of a quartz window which consists of the following components:

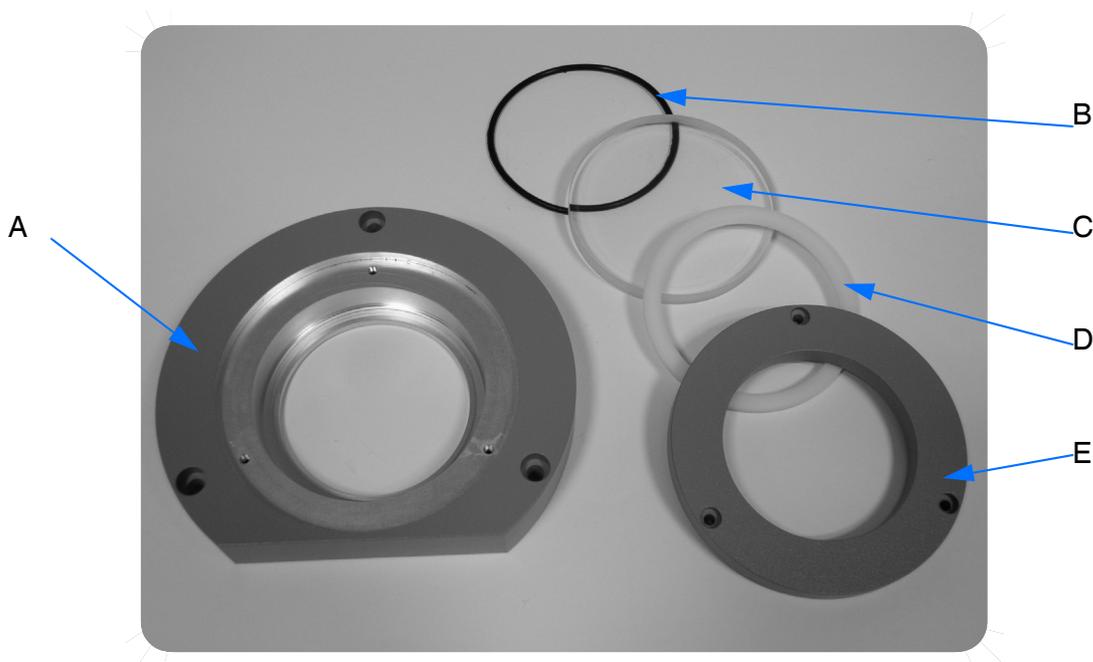


Figure 41: Quartz window and its components

	Definition
A	Window flange
B	O-ring
C	Window
D	Distance ring (only required for special window types)
E	Fixation ring

## Window Assembly

- Slightly grease the O-ring and insert it into the window flange.
- Put the window onto the O-ring in the window flange. Always wear gloves.
- Position the distance ring, if applicable.
- Position the fixation ring. Gradually tighten the screws one after the other.

**Caution:** Never insert a window which shows a sign of damage, e.g. a crack. The window may break under vacuum. A sudden implosion can cause severe damage. Never insert a window thinner than specified. It may break under vacuum.



## Window Flange Mounting

When mounting a window flange to the interferometer compartment make sure that the O-ring (A in figure 42) on the window rear side is slightly greased by vacuum grease to prevent the O-ring from drying out, and improve the seal tightness. The O-ring must tightly fit into the window groove (B in figure 42).

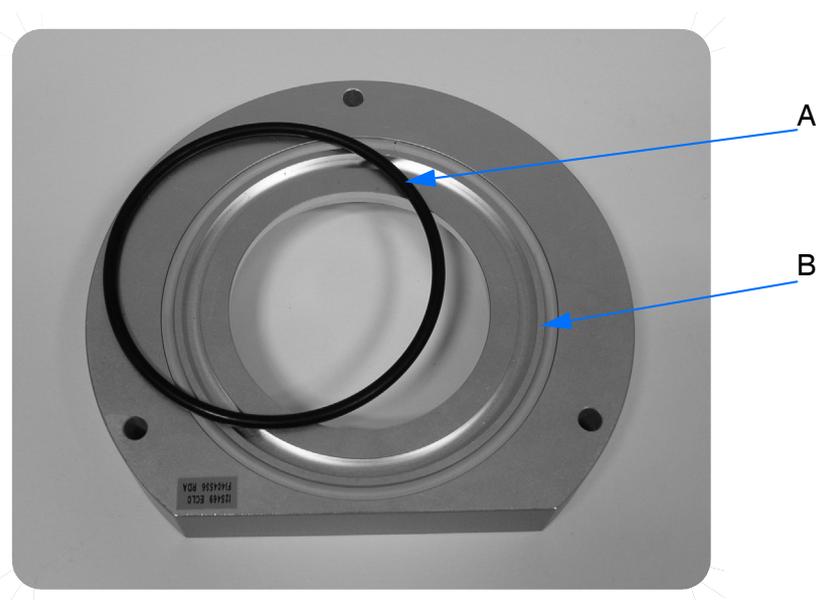


Figure 42: Window flange rear side

To mount a window flange onto the interferometer compartment, loosen the screws from the window cap (see figure 43) and fix the window flange with the rear side facing towards the interferometer compartment by gradually tightening the screws.

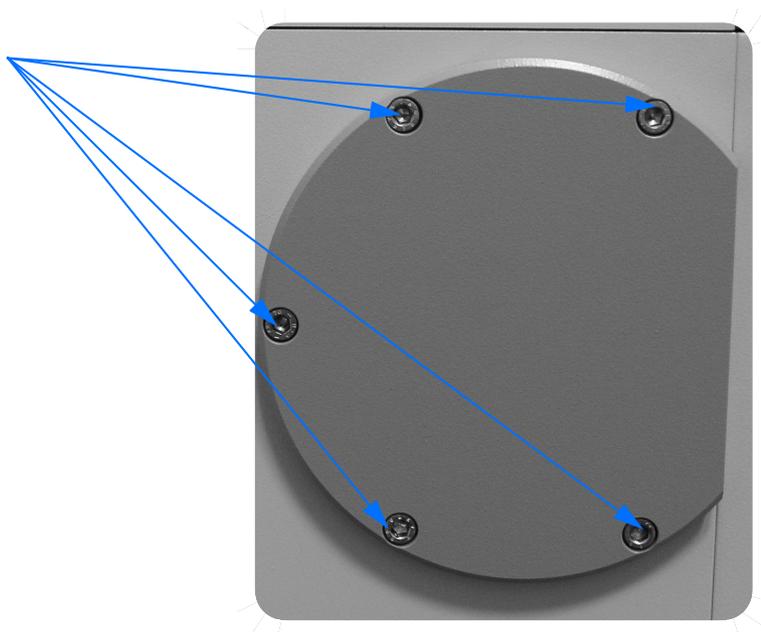


Figure 43: Window cap

The following table lists some of the window material available for IFS 125HR.

Material	Chemical Properties
Zinc Selenide ZnSe Caution - Toxic	Diameter: 42mm x 2 - 3mm, wedged Outer window for vacuum cylinder of A 570-A and A 578-A cryostats
Zinc Selenide ZnSe Caution - Toxic	Diameter: 26mm x 2mm Inner window for A 570-A cryostat
Potassium Bromide KBr	Diameter: 42mm x 2mm, wedged Outer window for vacuum cylinder of A 570-A and A 578-A cryostats
Potassium Bromide KBr	Diameter: 26mm x 2mm Inner window for A 570-A cryostat
Potassium Bromide KBr	For window flange W 108/x, diameter: 57mm x 8mm, wedged 6mrad
Potassium Bromide KBr	KBr window, 90mm x15mm
Calcium fluoride CaF <sub>2</sub>	90mm x 8mm
KRS-5 (TlBr/I thallium bromide-iodide) Caution - Very Toxic	Diameter: 42mm x 2 - 3mm, wedged Outer window for vacuum cylinder of A 570-A and A 578-A cryostats
Polyethylene PE	Diameter: 42mm x 2 - 3mm, wedged Outer window for vacuum cylinder of A 570-A and A 578-A cryostats
Polyethylene PE	Diameter: 26mm x 2mm Inner window for A 570-A cryostat
Quartz SiO <sub>2</sub>	For window flange W 108/x, diameter: 57mm x 8mm, wedged 6mrad

**Note:** When replacing windows always observe the product-specific safety data sheets.

## EVACUATING DETECTOR

Most liquid-nitrogen cooled detectors are mounted in re-pumpable vacuum dewars (except for those which are permanently sealed). Usually, the detector dewar holds its vacuum for several months. Evacuating the detector dewar becomes necessary if the hold time considerably decreases (i.e. a hold time of less than 4 hours). The existence of condensation water on the detector outside indicates that the dewar must be evacuated pretty soon. If there is frost on the outer detector surface, the dewar must be evacuated immediately. Before evacuating the dewar, the detector must be removed from the spectrometer.

To evacuate the dewar the following evacuating equipment is required:

- Turbo molecular pump / oil-free high-vacuum pump (which achieves an ultimate vacuum of  $<10^{-5}$ hPa)
- Vacuum adapter

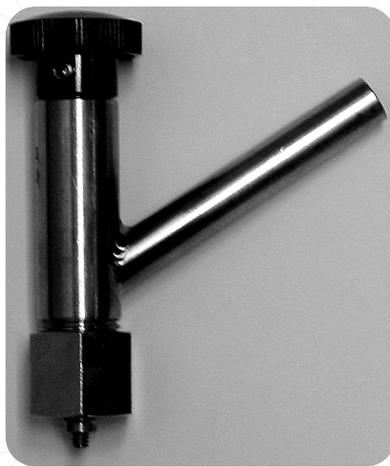
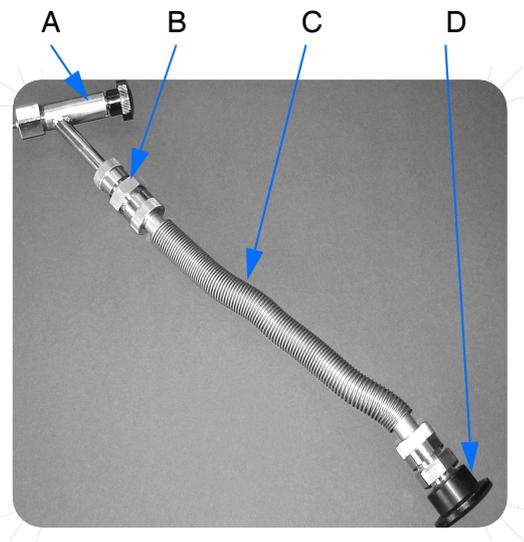


Figure 44: a) Vacuum adapter



b) Vacuum adapter with flexible metal hose

	Definition
A	Vacuum adapter
B	Flange
C	Flexible metal hose
D	NW 25 flange

## To evacuate the detector proceed as follows:

- 1 Connect the connecting piece of the vacuum adapter (E in figure 45) to the vacuum pump. The connecting piece has an outer diameter of 9.7mm.
- 2 Pull the knob (H in figure 45) to the open position and loosen the coupling nut (A in figure 45).
- 3 Carefully slip the vacuum adapter (F in figure 45) over the connecting piece of the detector dewar and fasten the coupling nut finger-tight. The O-ring (C in figure 45) must engage properly into the corresponding groove at the detector port. Additional tightening is not necessary.
- 4 Push the knob (H in figure 45) into the closed position until the union nut (D in figure 45) of the vacuum adapter is in contact with the dewar evacuation valve.
- 5 Screw the union nut into the dewar evacuation valve by turning the knob clockwise; 2 to 3 rotations are sufficient. Do not tighten the union nut completely as this would prevent it from being unscrewed later.
- 6 Evacuate the vacuum adapter by using the vacuum pump.

**Note:** The dewar must not contain any liquid nitrogen and should be at or slightly above room temperature (max. 60°C).

- 7 Pull the knob to the open position in order to open the dewar evacuation valve and evacuate the dewar.

**Note:** Evacuating the dewar takes several hours. Therefore, it is recommended to evacuate the dewar over night. The final pressure in the dewar has to be less than  $10^{-5}$ hPa.

- 8 If the desired vacuum has been achieved, gently push the knob to the closed position in order to close the dewar evacuation valve.
- 9 Vent the section between vacuum pump and vacuum adapter.
- 10 Rotate the knob several turns counterclockwise in order to screw the union nut off the dewar evacuation valve. Be careful not to vent the dewar.
- 11 Pull the knob to the open position, loosen the coupling nut and remove the vacuum adapter from the connecting piece of the dewar.

**Note:** Bruker offers a detector evacuating service (SD128): If you do not have the necessary evacuating equipment available, you can send the complete detector to Bruker.

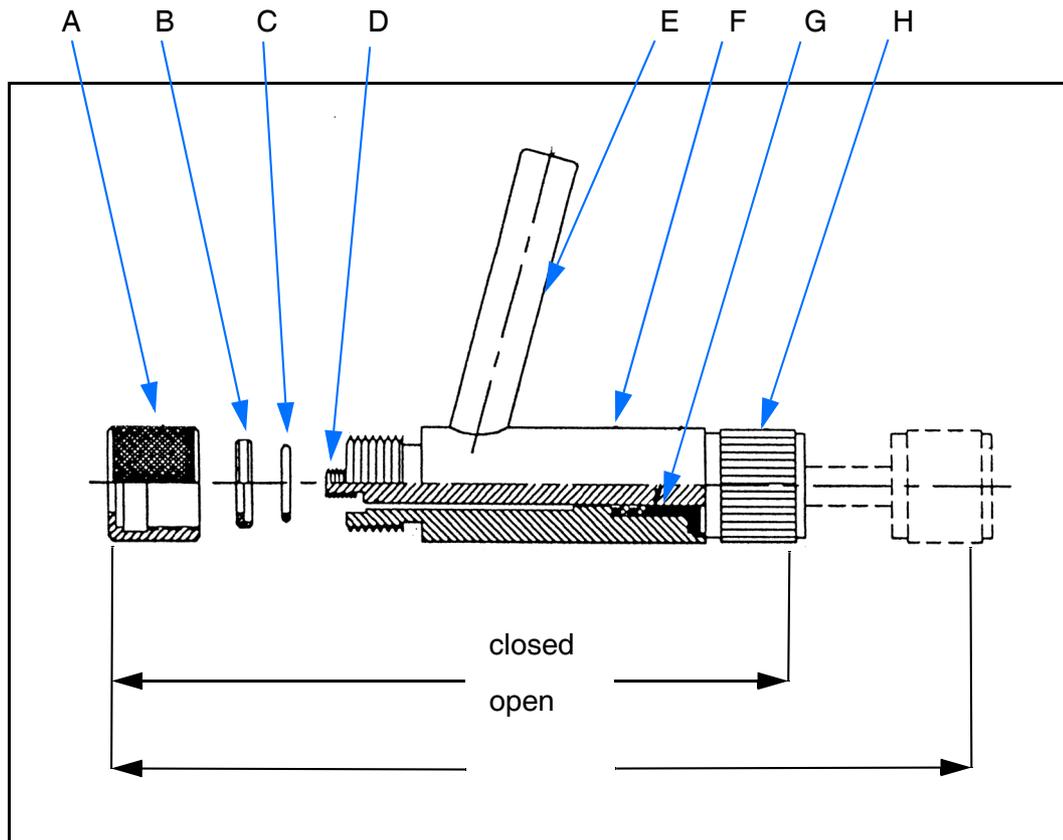


Figure 45: Vacuum adapter, cross section

	Definition
A	Coupling nut
B	O-ring retainer
C	O-ring
D	Union nut (to remove the valve closure of the detector dewar)
E	Connecting piece for vacuum pump
F	Vacuum adapter
G	Washer and O-ring packing
H	Knob

## VACUUM SYSTEM

For any service or maintenance issues refer to the vacuum pump manual provided by the pump manufacturer. The following instructions have to be seen as general considerations as different pump models can be supplied with the IFS 125HR spectrometer.

**Note:** The following instructions do not replace those indicated in the pump manual.

Typical user maintenance of the vacuum system may include:

### Checking Oil Level

Regularly check the oil level and add fresh oil when needed to ensure efficient operation and long component life. A permanent loss of oil may indicate leaks or oil degradation. Remedy this problem immediately.

### Replacing Oil

A certain amount of oil is lost during normal pump operation, which require small amounts of oil to be added from time to time. This kind of oil has to be approved by the pump manufacturer and compatible with the oil already used in the vacuum system.

Oil degradation will require a complete oil replacement. Refer to the diagnostics in the pump manual to see when the oil has to be completely replaced.

**Caution:** Some oils are easily oxidizable or inflammable. Inform yourself about the oil properties before filling the pump with a particular oil.



### Exhaust

The exhaust of the vacuum pump should be routed to external air. Check the exhaust lines once a month for substantial oil accumulation inside the lines. If you use a demister (highly recommended), it may become saturated with oil and the filter cartridge must be replaced (refer to the demister documentation).

## CLEANING RODS

Note that only the outer surface of the spectrometer can be cleaned by using a dry or damp cloth. Do not use detergents with organic solvents, acid or base.



**Caution: Do not clean the inner spectrometer compartments. This may lead to serious spectrometer damage.**

### Scanner Rods

Clean the rods regularly by using alcohol or acetone and a soft cloth.

Before switching on the scanner again, evacuate the spectrometer to prevent any solvent residue from affecting the gliding bearings. **Never apply any grease to the rods or the gliding pins!**

### Drive Cable

The drive cable for the moving mirror assembly must occasionally be checked for tension. Especially, when installing a new cable it is recommended to check the cable tension to avoid slipping. Always adjust the drive cable tension by the thumb screw (B in figure 46) and fix the tension by the counter screw (C in figure 46).

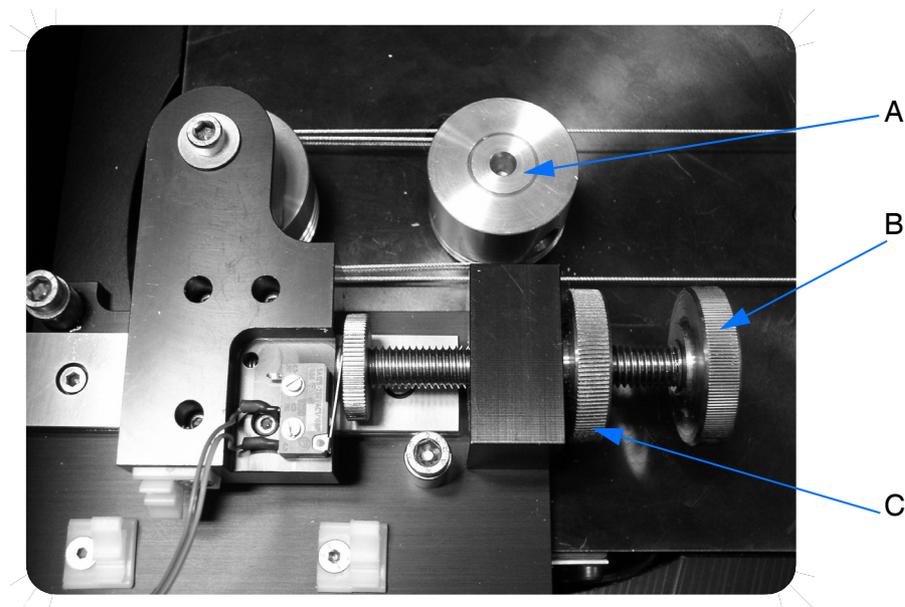


Figure 46: IFS 125HR - Scanner drive unit, DC motor

- Make sure that the drive cable does not touch the feed-through wall, see marking in figure 47, when the scanner is located in the middle of the scan path.
- There must be no signs of cable slipping at the capstan (A in figure 46) when the scanner turns at high velocity in long scan mode.

**Caution: Always tighten the thumb screw manually. Do not use any tool. Be careful not to overtighten the screw to prevent the cable from tearing.**

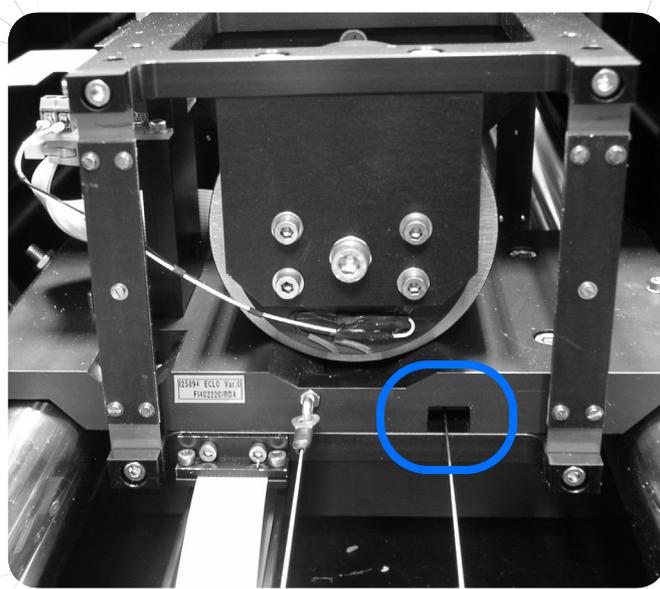


Figure 47: IFS 125HR - Scanner with drive cable



# TROUBLESHOOTING

---

This chapter describes the most common spectrometer problems, their potential causes and recommended solutions. The IFS 125HR design allows the operator to identify and correct many faults without requiring the support of the Bruker service.

The following diagnostic procedures are described:<sup>1</sup>

- All power supply LEDs off
- One power supply LED off
- No data transfer between spectrometer and computer
- RX LED permanently off
- RX LED on, but TX LED off
- SR LED permanently on
- No interferogram observable in *Check Signal* mode
- Signal-to-noise ratio too low
- Insufficient energy at the (high wavenumber) end of the spectrum
- H<sub>2</sub>O band absorption too high
- Spectral resolution not reached
- Incorrect abscissa (cm<sup>-1</sup>) calibration

---

1. Not all failures and causes can be outlined in this chapter. If the recommended solutions do not solve the problem, contact a Bruker service representative.

## SPECTROMETER FAILURE

### All power supply LEDs off

The power supply LEDs (figure 68) are located on the power supply panel, labeled +5V, +12V and -12V. These LEDs indicate the status of the secondary voltages of the electronics unit.

Possible causes	Solutions
Spectrometer is not turned on.	Turn on the spectrometer using the main power switch.
Power cord is not connected.	Connect the power cord to the power outlet as well as to the appliance inlet connector.
Voltage is not available.	Carefully check whether the proper voltage is supplied at the outlet which the spectrometer is connected to (for details see chapter 3).
Fuse is defective.	Check the main fuse, replace it when blown (see chapter 6).
Short circuit in the power supply unit.	Typically, a short circuit is accompanied by a <i>ticking</i> sound inside the power supply unit. Disconnect the power supply unit immediately. If any additional external circuitry is connected to the CAN bus or MPE port, disconnect them and try it again. If the problem has been solved, the external circuitry has caused the short circuit. Otherwise it is an internal problem of the spectrometer electronics. Contact your local Bruker service.
Power supply is defective.	Power supply needs to be replaced. Contact your local Bruker service if the LEDs are off.

## One power supply LED off

Possible causes	Solutions
An external device shortens the power supply.	Disconnect all external devices from the CAN bus or MPE port and try it again.
Temporary short circuit in the spectrometer.	Switch off the spectrometer, wait about 30 seconds and switch it on again. After the initialization cycle the power supply LED will turn to green.
One LED is defective.	In this case there is no spectrometer malfunction and the spectrometer operates properly. Replace the defective LED.

## No data transfer between spectrometer and computer

In this case the troubleshooting procedure depends on the connection topology. The default connection (stand-alone configuration) is installed via a cross-over cable between the PC and the spectrometer 10Base-T port (see appendix F, figure 67). Alternatively, the spectrometer can be directly connected to an Ethernet network using the 10Base-T port. The data transfer direction is indicated by the RX and TX LEDs on the spectrometer rear side. When sending data the TX LED lights, when receiving data the RX LED lights.

## RX LED permanently off

This indicates that there is a problem with regard to the physical connection between the spectrometer and PC or network.

Possible causes	Solutions
Wrong cable type is used.	Use a CAT5 cross-over 10Base-T cable to directly connect the spectrometer to the PC. Use regular CAT5 10Base-T cables (ask your network administrator) to connect the spectrometer to an existing network.
The cable is defective or the connection is unstable.	Check the RJ-45 connection to the ETH socket, and the connection at the other end of the cable. Replace the cable if necessary.
The spectrometer does not start up.	Check the main power supply. At least the power supply LEDs +5V, +12V and -12V must light when the spectrometer is switched on.

## RX LED on, but TX LED off

This indicates that a logical connection from the spectrometer to your network or computer is not available.

Possible causes	Solutions
Wrong IP address has been assigned to the spectrometer.	Assign the correct IP address to the spectrometer. You can find the correct IP address on a specific label on the power supply panel. (See figure 68) For detailed information, see appendix E.
TCP/IP settings mismatch between spectrometer and computer/network.	Refer to appendix E for configuration details.

## SR LED permanently on

A lighting SR LED indicates that the instrument is busy and not available for communication.

Possible causes	Solutions
Spectrometer is still in the initialization phase.	After switching on the spectrometer wait about 1.5 minute until the initialization phase is completed.
Spectrometer control hangs.	Reset the spectrometer by using the <i>Reset</i> button (figure 67) on the electronics panel and wait for the initialization to terminate. Check the spectrometer log file for possible causes (see chapter 8. In rare cases it may be required to switch off the spectrometer at the main power switch (N in figure 71 on page 156). Wait 30 seconds before switching it on again.

## No interferogram observable in *Check Signal* mode

Assuming that the spectrometer can be accessed and that there is an optical connection between the interferometer outlet and the detector inlet, the problem can be caused by:

Possible causes	Solutions
Optical path is blocked.	Check whether the accessory in the sample chamber blocks the IR beam.
Detector is not cooled down at operating temperature. The <i>Detector not ready</i> error message pops up.	Cool the detector. In case of a liquid-nitrogen cooled detector, fill liquid nitrogen into the dewar. (See chapter 5). In case of a thermoelectrically cooled detector, contact your Bruker service.
Detector is not installed or incorrectly installed. The <i>Device not connected. No analog board selected</i> error message pops up.	<b>Manually Changed Detectors:</b> check whether the detector is properly inserted into its holder.  <b>External detectors:</b> examine the cable connection at the detector as well as at the spectrometer rear side.
Defective or not correctly inserted light source. In this case the error message <i>Source is broken or not connected</i> appears.	Check whether the light source is inserted properly or replace the light source, if it is defective. (See chapter 6.)
Beam splitter is not properly installed. The following error message pops up: <i>NOT SCANNING. Laser-A modulation too small, Laser-B modulation too small, Laser signal modulation is too small.</i>	Check whether the beam splitter is properly installed, and the laser signals are in the specified voltage range (see chapter 6 - <i>Checking Laser Signals</i> ).
Beam splitter is damaged.	Replace the beam splitter and check the signal.
The red ERR LED on the electronics panel lights up, i.e. there is a spectrometer error, e.g. strong mechanical shocks have caused a temporary or permanent optics misalignment or the HeNe laser is defective.	In case of an optics misalignment, contact your local Bruker service. In case of a defective laser, a warning will be displayed by the application software. Replace the laser unit. Contact your local Bruker service.

Possible causes	Solutions
Power supply unit is defective.	Check the power supply LEDs on the power supply panel. If none of the LEDs lights, the power supply unit probably needs to be replaced. Contact your local Bruker service.
Detector oversaturation or ADC overflow	Reduce the light source intensity by using a smaller aperture, or reduce the gain settings.
Scanner is not scanning	Check the FWD and TKD LEDs on the electronics panel. If they do not lit repeatedly, see <i>Scanner Diagnostics</i> in this chapter.
Interferometer is out of alignment	Contact your local Bruker service.

## Signal-to-Noise Ratio too low

Possible causes	Solutions
Energy throughput is too low.	See <i>No Interferogram observable in Check Signal mode</i> in this chapter.
Detector is not cooled down to operating temperature. The <i>Detector not ready</i> error message pops up.	Cool the detector. In case of a liquid-nitrogen cooled detector, fill liquid nitrogen into the reservoir. In case of a thermoelectrically cooled detector, contact your Bruker service.
Light source is turned off.	Turn on the light source by using the software.
Light source is defective. The <i>Source is broken or not connected</i> error message pops up.	Replace the light source. See chapter 6.
Interferometer is out of alignment.	Contact your local Bruker service.

## Insufficient energy at the (high wavenumber) end of the spectrum

Possible causes	Solutions
Light source is defective. The <i>Source is broken or not connected</i> error message pops up.	Replace the light source (see chapter 6).
Interferometer is out of alignment.	Contact your local Bruker service.

## H<sub>2</sub>O Band Absorption too high

Possible causes	Solutions
Air humidity level inside the sample compartment is too high.	Purge the sample compartment using dry air or nitrogen gas (see chapter 3 and 5). Evacuate sample compartment.
Vacuum is not low enough.	Pump down to at least $3 \cdot 10^{-2}$ hPa.

## Spectral Resolution not reached

Possible causes	Solutions
Wrong aperture has been selected.	Decrease the aperture size.
Optical system is out of alignment	Contact your local Bruker service.

## Incorrect Abscissa ( $\text{cm}^{-1}$ ) Calibration

Possible causes	Solutions
For measurements requiring maximum precision, an abscissa calibration has to be performed.	Check the peak positions of a known reference gas (at low pressure), e.g. $\text{N}_2\text{O}$ and correct any deviations from the exact value by adjusting the laser wavenumber. Select the <i>Optics and Service</i> command from the OPUS™ <i>Measure</i> menu. Click on the <i>Interferometer/AQP</i> tab and enter the laser wavenumber into the corresponding entry field.

## Water Circulator

There are several possible causes why water is not circulating when the unit is powered:

Possible causes	Solutions
The fuse has blown.	Remove the fuse from the holder and measure the resistance across the two ends. If the measured resistance is more than a few ohms, replace the fuse by another one which has the same specifications.
Excessive deposit of debris on the heat exchanger.	Check the air intake filter on the water cooling unit for deposit of dust. If there is dust on the filter, use a vacuum cleaner to remove it. Cleaning the filter should be done regularly.
Air bubbles in the pump seizes up the pump.	Check the water level. If it is too low, add distilled water to the reservoir. Raise the cooling unit above the level of the sources. When the water circulates again the unit can be relocated to its former position.
Accumulated mineral deposits which seizes the pump.	Contact your Bruker service.
Worn bearings inside the pump.	Contact your Bruker service.

**Note:** Do not remove circulator covers without first obtaining detailed instructions from your Bruker service. The circulator has powerful capacitors inside which can hold significant and possibly dangerous voltages and charge even after the unit has been powered off for some time. Disconnecting the pump from the circulator inevitably results in the spilling of water inside the compartment.

## Vacuum System

For complete diagnostics and details to solve the problems caused by the vacuum system refer to the manufacturer manual.

<b>Problem</b>	<b>Possible Cause</b>
Pump does not rotate.	Pump seized as a result of stoppage after pumping under difficult conditions
	Coupling deteriorated. Replace coupling according to the manufacturer's manual.
	Temperature is too low. Wait until pump has reached the specified minimum operating temperature. Use low viscosity oil if problem persists.
	Oil is contaminated.
	Oil thickened due to prolonged storage or non-operation after pumping contaminants.
No oil in case	Oil inlet is partially clogged.
	Oil is contaminated, polluted or cold.
	Lubrication holes are blocked.
	Oil pump pinion is damaged.
	Blade and counter blade is out of adjustment.
Pump does not generate a vacuum, ultimate pressure obtained: some hPa	Insufficient oil in case
	Oil inlet is partially clogged or obstructed.
	Oil is contaminated or cold.
	Inlet filter is obstructed.
	Motor is underpowered.
	Exhaust is blocked.
	Spectrometer cover is not in place.
	Spectrometer port window broken.

Problem	Possible Cause
Pump does not generate a vacuum Ultimate pressure obtained is higher than $2 \times 10^{-2}$ hPa	O-ring is pinched or has become brittle. The latter is expedited by UV radiation or contact with liquid nitrogen.
	One shaft seal or valve has deteriorated.
	Gas ballast knob is open.
	Lubrication holes are blocked.
	Blade and counter blade is out of adjustment.
	Pump exhaust pressure exceeds 0.5bar.
	Oil mist eliminator (demister) cartridge is clogged.
Noisy pump	Oil is completely contaminated.
	Pump is not prepared for oil used.
	Motor is improperly powered and motor bearings are damaged.
	Coupling is poorly adjusted or has deteriorated.
	Fan improperly mounted.
	Vanes have deteriorated.
Pump too hot	Continuous high pressure operation ( $P > 30$ hPa)
	Ambient temperature is too high.
	Oil is polluted.
	Pump not prepared for oil used.
	Poorly ventilated environment.
	Vent openings are blocked.
	Overpressure at the pump exhaust.
	Supply voltage is too high or short circuit at motor.

<b>Problem</b>	<b>Possible Cause</b>
High oil losses	Continuous high pressure operation ( $P > 30 \text{hPa}$ )
	Pump is too hot.
	Leakage at case o-ring or shaft seal.
	Pump is pumping condensables.
	Gas ballast knob left in open position.
Pump not tight when stopped	O-ring is pinched.
	Valve or shaft seal have deteriorated.
	Oil is contaminated.
	Gas ballast knob was left in the open position.
Oil in the base	Oil case and housing is badly cleaned.
	Case o-ring is pinched.
	Shaft seal has deteriorated and the felt is saturated.



# WEB INTERFACE

## ACCESS RIGHTS

Especially, if the spectrometer is connected to a network, you should be aware of possible access conflicts.

- Only one OPUS™ instance can access the spectrometer at a given time. Any further OPUS instance - on a different PC - will be automatically blocked, indicated by a gray status light in the lower right corner of the concerned OPUS™ instance, and the *Optic Setup and Service* dialog as figure 48 shows.

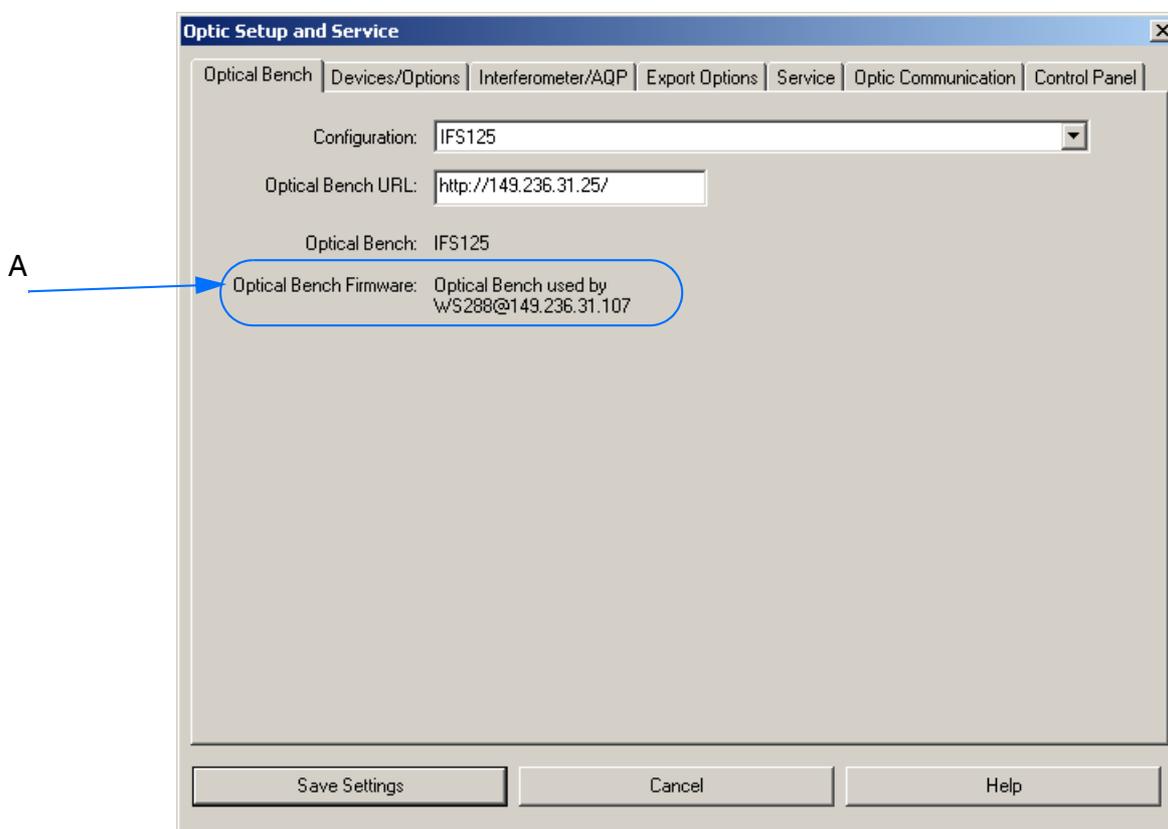


Figure 48: OPUS *Optic Setup and Service* dialog

The PC which has currently access to the optics is indicated (A).

- Many instances of a Web browser - on the same or on a different PC - may access the spectrometer simultaneously, even in parallel to an OPUS™ instance. All these instances are served on a first-come-first serve basis.

**Note:** Intentionally, there is no locking mechanism between the Web interface and OPUS™. Thus, you are strongly advised not to access the spectrometer by a Web browser in parallel to OPUS™, during normal measurements. Such parallel access is intended only for service and maintenance purposes. You may easily destroy your measurement or completely lock OPUS™ by a single click on a button (e.g. Reset instrument). If you are to have security or reliability concerns, use the stand-alone configuration (see appendix E) or consult your network administrator to restrict the access rights within the network.

## GENERAL INFORMATION ABOUT THE INSTRUMENT HOME PAGE

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The integrated EWS15 board (EmbWebServer Board) allows the spectrometer to operate like a web server, i.e. the spectrometer can be accessed using a web browser (e.g. Microsoft Internet Explorer, Netscape Internet Browser). This kind of spectrometer accessing requires a physical connection between IFS 125HR and PC as well as the spectrometer IP address.

If you open the web browser and enter the spectrometer IP address (default IP address: 10.10.0.1) into the address field of the web browser, the home page of the IFS 125HR spectrometer is displayed. See figure 49. If you do not know the IP address, see the white label at the electronics panel.

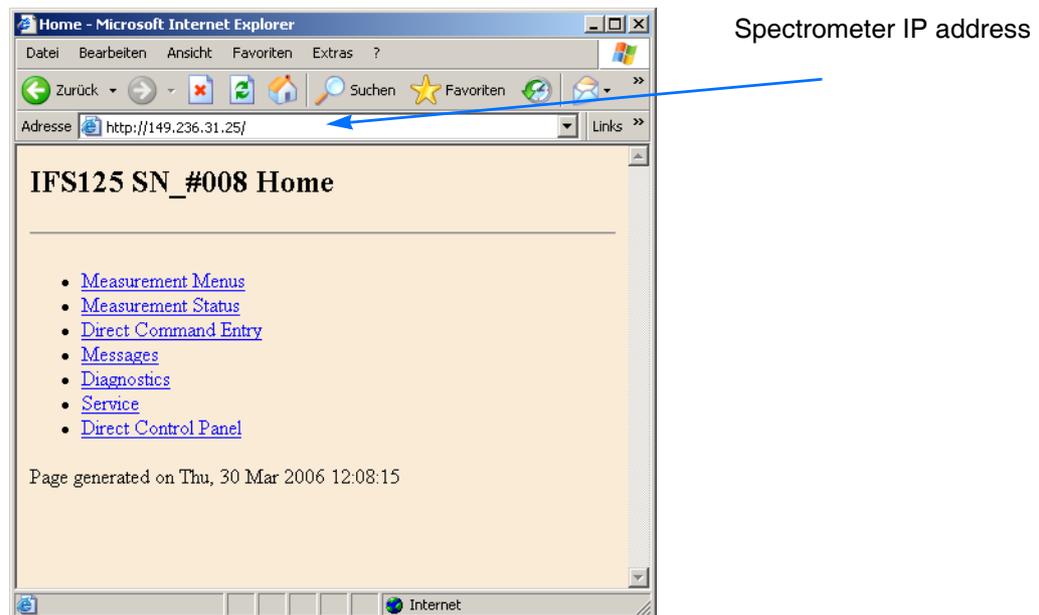


Figure 49: IFS 125HR home page

The IFS 125HR home page is a useful and powerful fault diagnosis tool, especially the menus *Direct Command Entry*, *Diagnostics* and *Service*. Therefore, only these menus (and their sub-menus, if available) are described in the following sections.

To a large extent the *Measurement Menu* menu is identical to the *Measurement* dialog of the OPUS™ software. See figure 50a and b. For more information about these parameters refer to the OPUS™ Reference Manual.

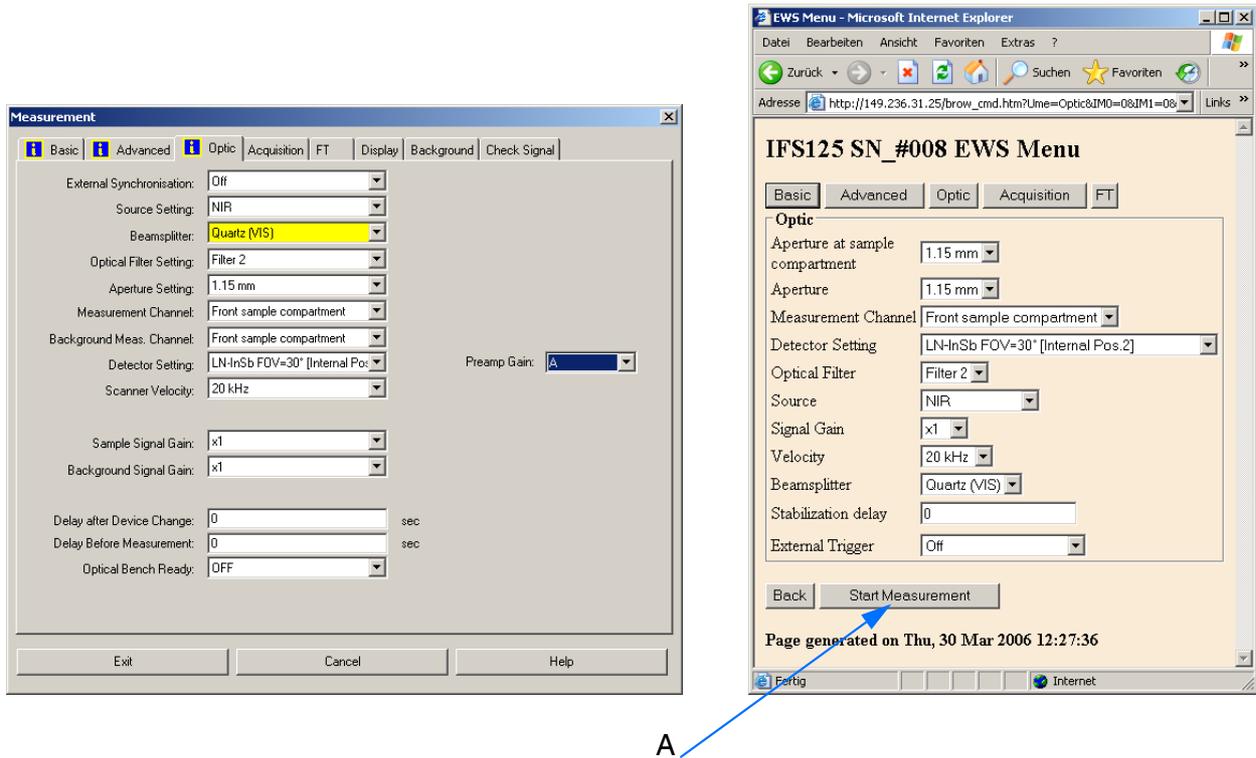


Figure 50: a) OPUS™ - Measurement dialog

b) Measurement menu (home page)

After clicking on the *Start Measurement* button (A in figure 50), the *Measurement Status* page opens. This page displays the progress of the data acquisition (e.g. remaining scans, remaining time) and the name of the currently created file. In addition, all errors occurring during the measurement are displayed in form of an error message as well.

The created interferogram files are stored in an internal buffer of the electronics and may be downloaded later (see **List of Result Data Files**). However, once the internal buffer is full, information will be lost. OPUS™ performs measurements employing the same mechanism, i.e. you will see the interferogram files requested from OPUS™ in the list of data files as well.

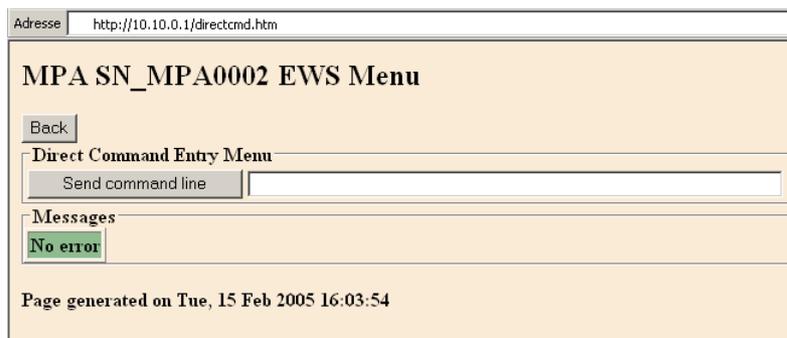
The *Messages* page lists all messages (errors, warnings etc.) that are also displayed on the *Measurement Status* and *Direct Command Entry* pages. Clicking on the *Auto-*

*Reload* button automatically updates the page every second. Thus, you can follow the messages almost in real time, without repeatedly clicking on the *Reload* button of the web browser.

## DIRECT COMMAND ENTRY

Using the web browser you can directly send commands to the spectrometer. This kind of communication helps to distinguish between problems caused by the spectrometer, and those resulting from the OPUS™ software.

Click on *Direct Command Entry* at the IFS 125HR home page. The following page is displayed:



The *Direct Command Entry* menu is similar to the *Direct Command Entry* function of the OPUS™ software. (See the OPUS™ Reference Manual.)

**Note:** For a list of available commands click on [Service](#) → [List of Commands](#) at the IFS 125HR home page.

The valid command syntax types are:

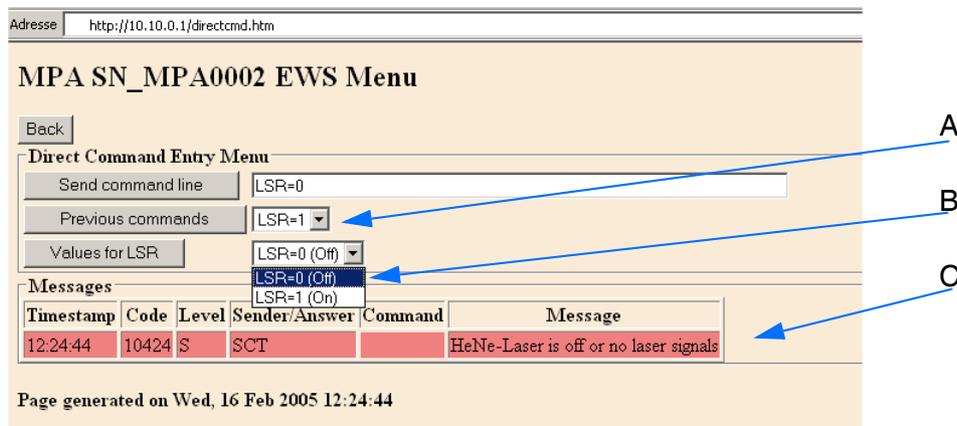
Text:	e.g. command for operator name	CNM=John Lemon
32 bit integer	e.g. command for number of scans	NSS=128
64 bit floating point number	e.g. command for resolution	RES=0.01
drop down list <sup>a</sup>	e.g. command for aperture	APT=2
Motor number and position <sup>b</sup>	e.g. command for stepper or DC motor	MOT229=1

a. In this case, the value is a 32 bit integer that is selected in a drop down list.

b. Commands for stepper or DC motors are low-level commands. They can be subject to change, i.e. they depend on the respective firmware version.

In the first entry line enter the command (e.g. LSR=1) and click on the *Send command line* button. Most commands are executed immediately. Commands concerning the scanner control and the data acquisition (e.g. VEL, RES), however, are at first only registered; they are executed when starting a measurement. If a command is to be executed immediately, add the *&\_SP=0* character string to the command (e.g. VEL=5000&\_SP=0). Moreover, several commands can be grouped by linking them with the *&* character (e.g. VEL=5000&NSS=32&APT=4&\_SP=0).

If you have already sent a command to the optics, one or two additional buttons including the corresponding drop-down lists (or entry line) are displayed. See the following figure.



The drop-down list (A) below the first entry line includes the command(s) previously sent to the spectrometer. To repeat a previous command select it from the drop-down list and click on the *Previous Commands* button.

The *Values for...* button is only displayed if the previous command is displayed in the form of a drop-down list (B). The *Values for...* drop-down list includes all possible values for a certain command. To set a value select the value from the drop-down list and click once on the *Values for...* button.

After the command has been sent to the spectrometer, all occurring warnings and errors are displayed in the group field *Messages* (C). In our example the command *LSR=0* has been sent. This command causes a HeNe laser to switch off which in turn deactivates the scanner control. This state of the optics results in the *HeNe-Laser is off or no laser signal* error message.

## Error Messages

An error message contains the following information:

- Creation time of the message
- Unique error message code (see also the sub-section *Additional Information about the Error Message Code* in this chapter)

- Importance level of an error/warning message indicated by a letter, e.g. Warning, Answer, Fatal, Informational, Static (see also the sub-section *Additional Information about the Error/Warning Message Importance Level* in this chapter)
- Origin of the message (device or routine name)
- The command that caused the error message. If it is a general message, this cell is blank.
- Error message text

**Note:** In case you do not know which values are accepted by a certain command (e.g. *APT*) send the command without any value as a dummy command to the spectrometer. As a result, the *Values for...* drop-down list including all possible values is displayed. Moreover, the error message *Value not in device table* will be displayed, which you can ignore.

## Additional Information about the Error Message Code

The error message code indicates which spectrometer component is defect or malfunctioning. The error message codes are grouped as follows:

Error Message Code	Spectrometer Component
10000 - 10999	Scanner (interferometer block)
20000 - 20999	Detector
30000 - 30999	Laser
40000 - 40999	Source
50000 - 50999	Automation units
60000 - 60999	Instrument

## Additional Information about the Importance Level of Error/Warning Messages

The error/warning messages are divided into static and non-static messages.

**Static error/warning messages are:**

Importance Level	Description
S (Static fatal error, non-resetable) R (Resetable static fatal error)	Messages of the importance levels <i>S</i> and <i>R</i> indicate a static fatal error which prevents a measurement from being executed, or cancels a running measurement. In this case, the Instrument Status LED in OPUS™ is red and an error message is displayed in OPUS™. The error remains until the problem has been solved or the unit causing the error is no longer selected (e.g. instead of a detector which is not cooled down to operating temperature, another detector has been selected).
V (Static warning, non-resetable) U (Resetable static warning)	Messages of the importance levels <i>V</i> and <i>U</i> indicate a static warning which does not prevent or cancel a measurement. In this case, the Instrument Status LED in OPUS™ is yellow, and an error message is displayed in OPUS™. The error state remains until the cause of the problem has been eliminated.

In case of static error/warning messages, there are resetable and non-resetable messages. If a resetable error/warning message is displayed, send the corresponding command to remove the error message.

In case of a non-resetable error/warning message, first eliminate the cause of the error, then send the corresponding command.

Example:

Messages					
Timestamp	Code	Level	Sender/Answer	Command	Message
09:43:46	51474	S	Cmd Interpreter	chn=1->MOT218	Device not connected

To remove the message shown in the above figure, either send a direct command to bring the motorized unit in its default position or connect the respective motor first and then send the direct command CHN=1 once again.

## Non-static error/warning message are:

Importance Level	Description
W/w (Warning message)	In case of a (non-static) warning message indicated by the importance level <i>W</i> or <i>w</i> , a measurement can be started and a running measurement is not cancelled. This kind of warning message is displayed only until OPUS™ has read the <i>Messages</i> page of the instrument home page.
A/a (Answer)	A message with the importance level <i>A</i> or <i>a</i> is the correct answer to a command with a return value. <b>Note: Commands without return value do not return an answer message.</b> This kind of message is displayed only until OPUS™ has read the <i>Messages</i> page of the instrument home page.
F/f (Fatal error)	A message with the importance level <i>F</i> or <i>f</i> indicates a (non-static) fatal error which prevents a measurement from being started, or cancels a running measurement. To eliminate this kind of error message, first solve the problem and then restart the measurement. This kind of message is displayed only until OPUS™ has read the <i>Messages</i> page of the instrument home page.
I/i (Information message)	A message with the importance level <i>I</i> or <i>i</i> provides additional information. <b>Note: Only some commands return a message with additional information.</b> This kind of message is displayed only until OPUS™ has read the <i>Messages</i> page of the instrument home page.

**Note:** If the importance level is indicated by an upper case letter, this means that the message in question is displayed only at the *Messages* page of the instrument home page. Whereas, if the importance level is indicated by a lower case letter, this means that the message is displayed also in OPUS™.

## DIAGNOSTICS

Click on the IFS 125HR home page on *Diagnostics*. The following page is displayed:

The screenshot shows a web page titled "MPA SN\_MPA0002 Diagnostics Page". At the top left is a "Refresh" button. Below it is a section titled "List of checked functions" containing a table with the following data:

<a href="#">Scanner</a>	ERROR
<a href="#">Detectors</a>	OK
<a href="#">HeNe Laser</a>	OK
<a href="#">IR Source</a>	OK
<a href="#">Automation Units</a>	OK
<a href="#">Instrument Ready</a>	OK

At the bottom of the page, it says "Page generated on Wed, 16 Feb 2005 14:49:23".

For diagnostic purposes, this page provides a rough overview of the functional state of the spectrometer. More precisely, it indicates the functional state of the following components: scanner<sup>1</sup>, detector, HeNe laser, IR source, automation units and electronics. The information on this page is identical to *Instrument Status* window in OPUS™ (see OPUS™ Reference Manual).

1. The terms *Scanner* and *Interferometer* are used synonymously.

## SERVICE

---

Click at the IFS 125HR home page on *Service*. The following page is displayed:



**Warning: The Service menu shall be accessed by the Bruker service only. Wrong entries will lead to spectrometer malfunction!**

### View Instrument Configuration

The *View Instrument Configuration* menu includes information about the embedded web server, the SCT15 board and the flange board. Moreover, it contains general information, runtime information, owner information and user information from EWS.INI.

### Full Report

The *Full Report* menu is described in detail in the following section.

### Log Buffer

The Log buffer is described in detail in the following section.

### Beep

Clicking on the *Beep* menu item induces the currently accessed spectrometer to beep shortly three times in succession. In case the IFS 125HR is connected to a network, this acoustic signal helps to identify the spectrometer in question.

## List of Commands

The *List of commands* menu includes almost all commands for controlling the spectrometer. See also section *Direct Command Entry*. Besides the actual commands (e.g. SRC), it also displays a short description (e.g. Source Setting) and the current value (e.g. NIR).

The number in the *Code* column is the code value for the corresponding current value, e.g. to activate the NIR source enter the following command: *SRC=104*. The bits in the *Busy status* column indicate whether the command is being executed by an internal unit. If there is any bit set in this column, this means that the command has been executed incompletely or unsuccessfully. Erroneously executed commands are indicated by an error flag in the last column. This page is also useful to check the parameters set for the last measurement by the OPUS™ software.

## List of Result Data Files

The *List of result data files* page displays the last three measurement files. These interferogram files have an OPUS™ compatible format and can be downloaded from this page by double-clicking on them. In addition, the data file status, running sample number, file header and file size of the most recently created file is displayed. The file names are created automatically and each file name is unique until the number of performed measurements exceeds 100 million. In this case, the file number restarts from 0.

## Special Commands A and B

The *Special commands A and B* menu items contain commands for setting parameters. Some of them cannot be set using the OPUS™ software. See the following figure.

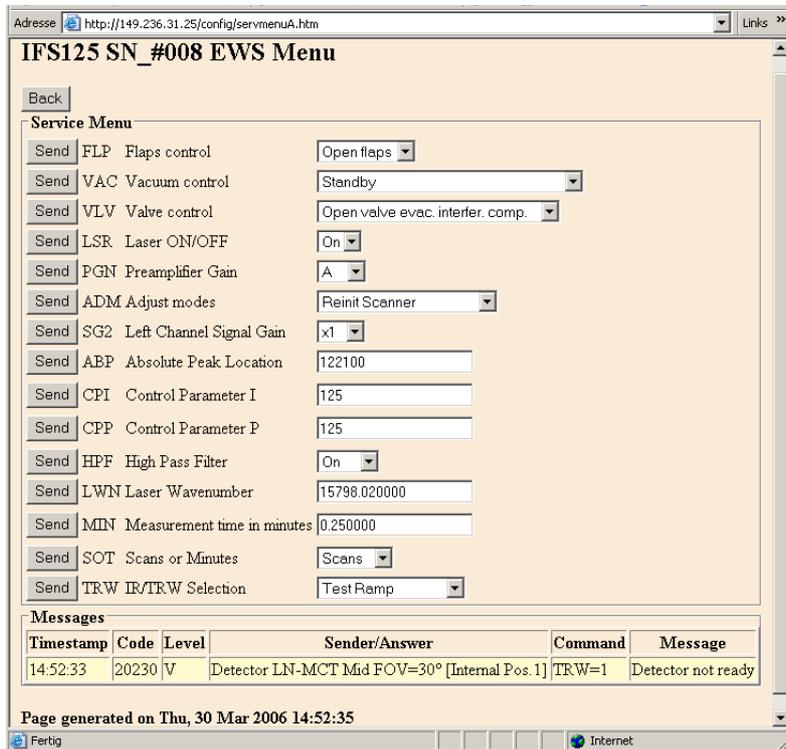
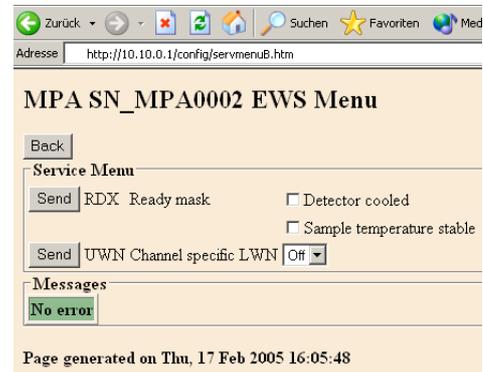


Figure 51: a) Special Commands A



b) Special Commands B

Note that these parameter settings are used for all the following measurements until these parameters are reset or the spectrometer is switched off.

Possibly, the following commands are useful for testing and diagnostic purposes. Some of them can also be entered as direct commands.

- **LSR Laser ON/OFF:** This command effects a HeNe laser switch-off and a laser error without opening the optics compartment. The corresponding error message is displayed in the *Message* group field.
- **ABP Absolute Peak Position:** Enter the desired absolute peak position manually in the corresponding entry field. This position will determine the default scanning position of the interferometer. For double-sided data acquisition, the scanner moves around this position. This command is used for setting the peak position which is displayed on the *Check Signal* tab of the OPUS™ software.
  - Sending a positive value will save the absolute peak position permanently.
  - Sending a negative value will set the absolute peak position only temporarily, i.e. the peak position is not saved. After restarting the spectrometer, the permanently saved value will be used.
  - Sending the  $ABP=0$  command will use the peak position value of the last measurement. This value will be saved permanently.
  - Sending the  $ABP=-1$  command will restore the saved peak position. This command cancels the temporarily peak position that has been set by sending a negative value.

- **ADM (Adjust Mode):** This command causes a change of the scanning mode. There are 6 adjust modes:
  - The *ADM=0* command (Reinit Scanner) re-initializes the scanner control like a recovery after a laser error. This command also terminates all other adjust modes and returns to laser-controlled scanning, if possible.
  - The *ADM=1* command (Fast Adjust Mode) causes a rapid scanner movement between the two light switches without requiring a proper laser signal. This command is intended for a coarse adjustment of the laser signal over the whole scanning range. For a fine adjustment of the laser signal, use the slow adjust mode described below.
  - The *ADM=2* command (Stop Mode) causes a scanner stop.
  - The *ADM=3* command (Slow Adjust Mode) checks the proper scanner movement. Similar to *ADM=1*, but with slower speed.
  - The *ADM=4* command (Front Short Adjust Mode) commutes the scanner around the front position without requiring a proper laser signal.
  - The *ADM=5* command (Back Short Adjust Mode) commutes the scanner around the end position without requiring a proper laser signal.

If the spectrometer is in an adjust mode unequal to 0, no measurement is possible.

- **CPI/ CPP (Control Parameters Integral and Proportional):** CPI and CPP are the basic scanner control parameters. Their default values are 125. Do not change them unless there is a scanner control problem. These values can be optimized for an operation in a vibrational environment.
- **HPF (High Pass Filter):** This command activates or deactivates the integrated digital high pass filter at 1.8Hz to eliminate the DC value of the interferogram. By default the high pass filter is switched on. For DC (direct current) measurements, it has to be switched off.
- **LWN (Laser Wavenumber):** This value represents the current laser wavenumber. The nominal value is 15798.0. You can use this command to change the value manually. Note that this value is automatically adapted to the particular channel if the *channel-specific wavenumbers* feature is activated.

**Note:** The nominal value  $15798.0\text{cm}^{-1}$  is equivalent to the wavelength of the HeNe laser of 632.8nm. The analog signal acquired by the detector is digitized using zero crossings of the HeNe signal, which ensure equidistant data points (“Connes-Advantage of FT-IR spectroscopy”).

The wavenumber axis of the spectrum can be calibrated by setting a slightly different laser wavenumber, so that the measured line positions of a known reference gas match with their true values.

## Check Spectrometer Components

The information of the *Check Detectors*, *Check HeNe Laser*, *Check Source*, *Check Scanner*, *Check Automations* and *Check Ready* menus is identical to the information displayed in the *Diagnostics* menu of the IFS 125HR home page. See above section.

## Reset Instrument

Clicking on the *Reset Instrument* menu item performs an instrument reset after a second confirmation.



**Warning: Do NOT click on this menu item while a measurement is performed in OPUS™. This can cause OPUS™ to hang up, i.e. the measurement is interrupted and no results will be delivered.**

## Last CAN Answer

The *Last CAN answer* page displays the last answer of the last CAN packet allowing to evaluate the CAN communication. The information of this page is only helpful when you know how the CAN communication works.

## Edit Hardware Configuration

**Note: Any wrong entry will lead to spectrometer malfunction! Do not change parameters, unless you are sure about the consequences!**

Clicking on *Service* → *Edit hard. conf.* opens the following page:

Adresse <http://149.236.31.25/config/hardware/> Links

### IFS125 SN\_#008 Hardware

- [<< One Level Back](#)
- [EWS TCP/IP Setup Menu](#)
- [Edit EWS.INI](#)
- [Edit AAR.INI for Auto Accessory Recognition](#)
- [Edit Optical configuration files for beampath](#)
- [Set Time & Date](#)
- [Edit ANA15 board data](#)
- [Edit ANA15 board Location ID chip](#)
- [Edit Matrix Flange board](#)
- [Backup Flange Eeprom data to Flashdisk](#)
- [Restore Flange Eeprom data from Flashdisk](#)
- [Edit Beamsplitter Eeprom](#)
- [Backup NVRam to Flashdisk](#)
- [Restore NVRam from Flashdisk](#)
- [Again detect ANA15 boards](#)
- [Update Firmware Can Device](#)

Page generated on Fri, 31 Mar 2006 09:21:48

## Beam Splitter

Clicking on *Edit Beamsplitter Eeprom* opens the following page:

Adresse <http://149.236.31.25/config/hardware/editBmsId.htm> Links

### IFS125 SN\_#008 Beamsplitter EEPROM

Beamsplitter Data ID\_No: 0114243D

Beamsplitter type: Quartz (VIS)

High wavenumber limit: 25000

Low wavenumber limit: 8000

Laser amplifier on:

Scanner will continue to move during evacuating or venting:

Save Back

Messages

No error

Page generated on Fri, 31 Mar 2006 09:32:07

Description of the editable fields:

- A** The name of the beam splitter as it appears in the OPUS™ *Beam splitter* drop-down list. **Note: If you make any changes to the name, previously-defined experiments using this type of beam splitter will not work any more!**
  - B** These limits will be used by OPUS™ to generate the yellow warning messages when you have requested a wavenumber range outside the limits.
  - C** If checked, the laser amplifier will be in the high gain mode. For details see chapter 6, *Checking Laser Signals*.
  - D** If unchecked, the scanner will automatically stop during evacuation and venting. Should be unchecked for all Mylar® beam splitters, as they will vibrate during turbulent gas flow leading to unstable scanner movement.
- Click on the *Save* button to write any changes to the beam splitter. Wait until finished.
  - Open the beam splitter locking door once to let the spectrometer electronics adapt the changes.

## FULL REPORT

---

The full report is a useful fault diagnosis tool. It provides the service technician all the necessary information about the spectrometer changes

### Generating a Full Report

In case of a spectrometer malfunction *immediately* generate a full report. To do this, proceed as follows:

- Open the web browser and enter the known spectrometer IP-address into the address field of the web browser. If the spectrometer is directly connected, the IP-address is *http://10.10.0.1*. The following dialog opens:



- Click on *Service*.
- Click on *Full Report*.

**Save or print the full report instantly after a problem or failure has occurred!** Otherwise, important information will be overwritten by newer ones.

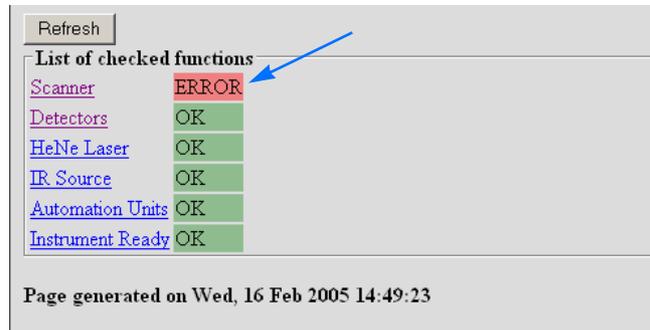
To do this, proceed as follows:

- Select the *Save as* (for sending it as an e-mail attachment) command of the *File* menu in the web browser.

**Note:** Always save the full report as *\*.htm* file.

### Interpreting a Full Report

The full report summarizes the information of the IFS 125HR web pages discussed above. It contains all information about the spectrometer. In case of a spectrometer problem, the full report helps the service technician to quickly narrow down the cause of the problem. To quickly locate a source of trouble simply scroll down the full report until you encounter a red ERROR field, see the following figure. For a more detailed fault diagnosis read through the individual information provided in the full report.



The full report includes the following sections:

- Flange board
- General info
- Runtime info
- Owner info
- User info from EWS.INI
- Embedded Web Server
- SCT15 Board
- Log buffer
- List of checked functions
- Scanner
- Detectors
- HeNe Laser
- Source Setting
- Details of Source(s)
- Ready status
- List of Commands
- CAN Devices
- COMBO Cmds
- Additional parameters for Cmds
- Auto Accessory Recognition
- EWS.INI

As the full report contains a lot of information, only the information relevant to fault diagnosis are described in the following.

The *Flange Board* group contains the following important information:

- Instrument Type
- Instrument Serial Number
- Firmware Version

Based on the instrument serial number you can request from Bruker the customer documents to get the acceptance test spectra and detailed information about the specific

IFS 125HR configuration. Comparing the spectra and/or the full report with the data of the final acceptance test may enable you to trace back the problem. The firmware version is an essential information as some problems can be related to rare incompatibilities of firmware and OPUS™ or firmware and hardware.

In case of the *General info* group different parameter files belong to the fault diagnosis relevant information. The *Parameter file* (with PA in its file name) contains all parameters and commands that are applicable to all Bruker spectrometers (e.g. MATRIX-F). The *Second Parameter file* (with PB in its file name) contains all parameters and commands that are applicable to the basic spectrometer configuration of IFS 125HR. The *Options Parameter file* (with PO in its file name) contains all parameters and commands that are required for additional/optional accessories or equipment. For example, an instrument can be equipped with a dichroic beam splitter. These files help to check whether the firmware is matching up with the hardware or not.

In the *Owner info* group you can find out whether a PC on which OPUS™ runs is currently connected to IFS 125HR.

In the *Embedded Web Server* group, the EWS15 firmware version, IP address, subnet mask address, gateway address and hardware MAC ID are displayed.

The *Log buffer* is a very helpful tool for analyzing an error status as it logs the last internal spectrometer actions. You can check the IP address of the user accessing the spectrometer and all commands sent to the spectrometer by OPUS™ or by the web browser. Additionally, some internal commands are logged as well. All these pieces of information have a time stamp.

The *Log buffer* can even help to diagnose the cause of a problem if the system hangs. The last logged spectrometer actions are stored in a non-volatile RAM. If the system hangs, switch it off (or press the *Reset* button) and restart it. After the system has booted, the lower part of the log buffer displays the last actions before the system reset. This section is separated by a dash line and can be identified by its date and time. For an off-line diagnosis, copy the content of the log buffer to a text editor and print it.

The following figure shows how a problem is displayed in the log buffer. The problem exemplifies the following: an MPA spectrometer is to execute the command SNR=7 (i.e. the sample changer wheel is to move to wheel position 7) with the sample changer wheel removed.

The motor number for driving the sample changer wheel (SCWHL) is MOT=230.

```

Logbuffer
050726 10:47:05-Contact=149.236.31.147
050726 10:45:58-"WS123" has read Config Page
050726 10:45:58-CAN->MOT208=1 returned
050726 10:45:58-CAN->Answer   FO 08 50 81 10 15 01 00 00 00 (HEX)
050726 10:45:58-CAN->Executing DIA=A 5000 203->MOT208=0  50 02 FO 03 (HEX)
050726 10:45:58-CAN->MOT208=0 in Can_queue
050726 10:45:58-CAN->MOT210=1 returned
050726 10:45:58-CAN->Answer   FO 08 52 81 10 15 01 00 00 00 (HEX)
050726 10:45:58-CAN->Executing DIA=A 5200 203->MOT210=0  52 02 FO 03 (HEX)
050726 10:45:58-CAN->MOT210=0 in Can_queue
050726 10:45:58-DSPDRV->_GI=0 returned
050726 10:45:58-DSPDRV->_GI=0 in Dsp_queue
050726 10:45:54-Contact=149.236.31.177
050726 10:45:53-EWS.133 - Level=I Origin=Auto CANBUS Cmd=Init MOT230 (0x6600)
Msg=Detection Successfully done
050726 10:45:53-CAN->SNR=7 returned
050726 10:45:53-CAN->SNR in Can_queue
050726 10:45:53-EWS.203 - Level=f Origin=CAN packet sender Cmd=SNR=7->MOT230=7 Msg=PIC
reported an error
050726 10:45:53-EWS.227 - Level=W Origin=CAN Task Cmd=SNR=7->MOT230 Msg=Error while
executing command
050726 10:45:53-CAN->Executing SNR=7->MOT230=7  66 07 FO 02 07 00 00 00 30 (HEX)
050726 10:45:53-CAN->MOT230=7 in Can_queue
050726 10:45:53-*Query=SNR=7
050726 10:45:53-Contact=149.236.31.147

```

If you scroll down to the *List of Commands* group a sample changer error is displayed at this place as well.

List of Commands						
Name	Description	Current Value	Code	Busy status	Ready	Error
APT	Aperture	Filter BRM2065	3001	0x0000	READY	
SRC	Source Setting	High Intensity NIR	100	0x0000	READY	
CHN	Measurement Channel	Sample Compartment	1	0x0000	READY	
GTP	Get Temperature	1		0x0000		
PGN	Preamplifier Gain	A	0	0x0000	READY	
SNR	Sample Changer	???	0	0x0000		ERROR
SST	SetTemperature	0.00		0x0000		
DTC	Detector Setting	External	16480	0x0000	READY	
LSR	Laser ON/OFF	On	1	0x0000	READY	

The *List of checked functions* provides a rough overview of the functional state of the spectrometer, more precisely, it indicates the functional state of the following components:

- Scanner (interferometer)
- Detector
- HeNe laser
- IR source
- Automation units
- Electronics

The information on this page is identical to the *Instrument Status* dialog in OPUS™, see the OPUS™ Reference Manual. If an ERROR is displayed, click on the respective component to get more detailed information.

## Fault Diagnosis in case of a Scanner Problem

Scanner				
Scanner Status	Idle			
Scanner	Front	Peak	Center	Back
Position [fringes]	0	30783	37061	70282
Drive Power [%]	51	8	0	-46
Lasersignals	Front	Life max.	Life min.	Back
Laser A Ampl. [mV]	4612	4862	4641	4519
Laser B Ampl. [mV]	4350	4624	4309	4210
Laser A Offs. [mV]	-6126	-5802	-5916	-6085
Laser B Offs. [mV]	-5301	-4868	-5060	-5301
Scannerblock Temperature [°C]	38.8			
Humidity IF Compartment [%]	50			

The *Scanner* line includes the prominent positions of the scanner on its scan travel.

- Front: Position of the front light switch. This position is by definition always 0.
- Peak: Peak position relative to the front position in half laser periods.
- Center: Position half between front and back
- Back: A fixed position at 4,000,000 half laser periods

*Laser A Ampl. [mV]* and *Laser B Ampl. [mV]*: All laser amplitude values should be > 1000mV and < 17000mV. If they are < 1000mV, the laser signal needs to be aligned. If the values are > 17000mV, the laser beam needs to be attenuated.

*Laser A Offs. [mV]* and *Laser B Offs. [mV]*: Values smaller than -8500mV indicate that no laser light reaches the interferometer block. Cause: The laser is switched off or the laser beam is out of alignment. A great difference between the *Life max.* value and the *Life min.* value (> 1000mV) indicates that the laser beam is not properly aligned (see *Checking Laser Signal* section in chapter 6).

**Note:** As a rough rule of thumb, the scanner block temperature is a few °C above the ambient temperature when thermally equilibrating the system. The ambient temperature range for an operating IFS 125HR is specified between 18°C and 35°C, see Installation. Consequently, a scanner block temperature above 40°C indicates that the spectrometer is not operated within the specified temperature range. There is no humidity sensor inside IFS 125HR.

## Fault Diagnosis in case of a Detector Problem

All available detectors are listed in the full report, see the following figure. This group field provides the following fault-diagnosis relevant information for each detector:

- Which detector is currently selected?
- Is the detector cooled down to operating temperature? An operable detector is indicated by a READY preamp board status.

TE-InGaAs [Internal]					
Detector selected	YES	DTC=0x4020	PIC Vers 2.5	SNo. IMTxxxx	ECL00
Ana15 board settings	MUX=IR	TRW=OFF	HPF=ON	GNS=1	SG2=1
Preamp board status	READY	PreampPower=ON	PGN=3 (0..3)		
Detector properties	Range: 4000..12000wn	Vels: 400..10000..80000 Hz	NL coef 0wn, 1.000	Recov. time: 1s	
	Gains: 1.0/10.0/100.0/0.4	Delays: 1100/7600/8500/500ns	Error Level: Error after timeout		
RT-InGaAs [External]					
Detector selected	NO	DTC=0x4060	PIC Vers 2.7	SNo. IMR001	ECL00
Ana15 board settings	MUX=IR	TRW=OFF	HPF=ON	GNS=1	SG2=1
Preamp board status	READY	PreampPower=OFF	PGN=0 (0..3)		
Detector properties	Range: 4000..12000wn	Vels: 400..10000..80000 Hz	NL coef 0wn, 1.000	Recov. time: 1s	
	Gains: 1.0/10.0/100.0/0.4	Delays: 1100/7600/8500/500ns	Error Level: Error on measurement		
RT-PbS [External]					
Detector selected	NO	DTC=0x4061	PIC Vers 2.7	SNo. IMR001_1	ECL00
Ana15 board settings	MUX=IR	TRW=OFF	HPF=ON	GNS=1	SG2=1
Preamp board status	READY	PreampPower=OFF	PGN=0 (0..0)		
Detector properties	Range: 3500..12800wn	Vels: 400..10000..40000 Hz	NL coef 3350wn, 0.900	Recov. time: 3s	
	Gains: 1.0/1.0/1.0/1.0	Delays: 1000/1000/1000/1000ns	Error Level: No Error Messages		

## Fault Diagnosis in case of a HeNe Laser Problem

In the full report you can find out whether the HeNe laser is switched on or off (current state: on or off). In case of a laser problem the current state is highlighted in red and the *Scanner Diagnostics* page shows an error as well.

HeNe Laser			
Current state	Off		
Desired state	On	LSR=1	READY
Total run time	311 days, 14 hours, 47 mn	since Tue, 26 Oct 2004 11:26:06	RESET

## Fault Diagnosis in case of a Source Problem

In case of the IR source the full report provides the following fault-diagnosis relevant information:

- Current state: IR source is on or off
- Total run time: compare the displayed total run time with the specified average service lifetime of the IR source.

Source			
Desired state = NIR (SRC=104) READY			
Details of Source(s)			
IR Source type	Current state	Total run time	In use since
NIR (SRC=104)	ON	76 days, 18 hours, 1 mn	Tue, 02 Mar 2004 16:47:59
MIR (SRC=105)	OFF	64 days, 18 hours, 15 mn	Mon, 01 Mar 2004 19:06:31
FIR (SRC=106)	OFF	36 days, 10 hours, 6 mn	Fri, 24 Jun 2005 17:27:52

## Fault Diagnosis in case of an Automation Unit Problem

List of Commands						
Name	Description	Current Value	Code	Busy status	Ready	Error
APT	Aperture	Filter BRM2065	3001	0x0000	READY	
SRC	Source Setting	High Intensity NIR	100	0x0000	READY	
CHN	Measurement Channel	Sample Compartment	1	0x0000	READY	
GTP	Get Temperature	1		0x0000		
PGN	Preamplifier Gain	A	0	0x0000	READY	
SNR	Sample Changer	???	0	0x0000		ERROR
SST	SetTemperature	0.00		0x0000		
DTC	Detector Setting	External	16480	0x0000	READY	
LSR	Laser ON/OFF	On	1	0x0000	READY	

The *List of Commands* includes the following important information:

- Name: command to control a component, e.g. switching the laser on or off, or to set a parameter, e.g. preamplifier gain
- Description: component or parameter which the corresponding command concerns
- Current value: displays the current command value
- Ready: indicates that the respective component is in operating condition

**Note:** If a unit or a command has not been used since the last power up, the *Ready* field may be empty.

- Error: indicates an error status of the component in question.

## CAN Devices Table

Mot Number	Hex Address	Type	Used in	Current Pos	Timeout	Status Ready	Error	Running	Initialized	Connected	Firmware version
0	0x8000	Motor		0	10				X		
22	0x9600	Motor		0	45				X		
23	0x9700	Motor		0	30				X		
32	0xA000	Motor		0	10				X		
191	0x3F00	Heatable Vial Holder (DD)	GTP	0	2				X	X	1
220	0x5C00	Aperture (10)	APT	0	10				X	X	15
224	0x6000	MPA Controllerboard (12)	CHN	0	20				X		A1
225	0x6100	MPA Controllerboard (12)	CHN	0	20				X	X	A1
226	0x6200	Measurement Channel (DC)	CHN	0	2				X		A1
227	0x6300	MPA Controllerboard (12)	CHN	1	20				X	X	A1
228	0x6400	MPA Controllerboard (12)	CHN	1	20				X	X	A1
229	0x6500	MPA Controllerboard (12)	CHN	1	20				X	X	A1
230	0x6600	Sample Changer (E2)	SNR	0	25				X	X	A1
231	0x6700	MPA Controllerboard (12)	CHN	-32	2	READY			X	X	A1
1231	0x6720	Humidity Sensor HF2320 (A8)		0	1				X		A1

CAN device is connected.

CAN device is not connected.

The *CAN Devices* table provides the following information relevant to fault diagnosis:

- Is the CAN device connected?
- What is the current status of the CAN device: ready, error or running? If a time-out error is displayed, this means that the unit has been connected wrongly or that the unit is connected correctly, however, the motor jams.

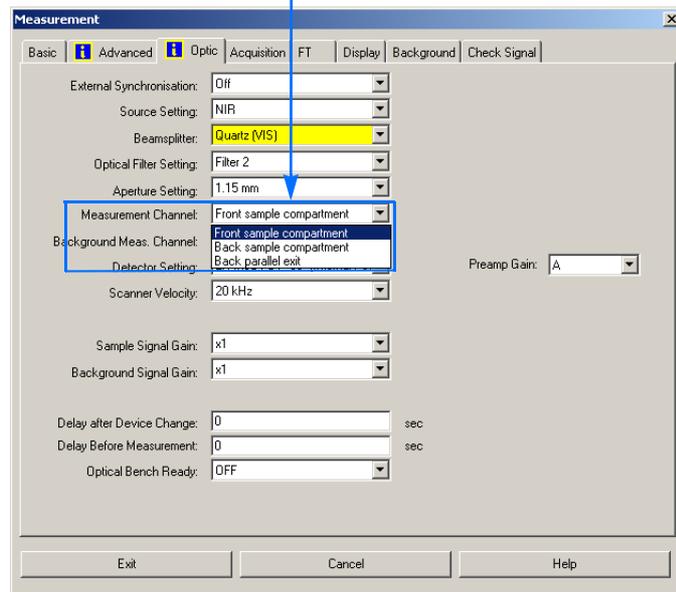
On the basis of the *Mot Number* you can identify the component.

**Note:** A motor number has been assigned to all CAN devices, even if the CAN device does not have a motor, e.g. source or valve.

If the CAN bus connectors at the spectrometer flange panel have not been plugged in (e.g. after transporting the instrument), all motors of IFS 125HR are displayed as *not connected*.

## COMBO Table

COMBO Cnds	
AP2	*1500=0.5 mm@*1800=0.8 mm@*11000=1 mm@*11150=1.15 mm@*11300=1.3 mm@*11500=1.5 mm@*11700=1.7 mm@*12000=2 mm@*12500=2.5 mm@*13150=3.15 mm@*14000=4 mm@*15000=5 mm@*16300=6.3 mm@*18000=8 mm@*110000=10 mm@*112500=12.5 mm@
APT	*1500=0.5 mm@*1800=0.8 mm@*11000=1 mm@*11150=1.15 mm@*11300=1.3 mm@*11500=1.5 mm@*11700=1.7 mm@*12000=2 mm@*12500=2.5 mm@*13150=3.15 mm@*14000=4 mm@*15000=5 mm@*16300=6.3 mm@*18000=8 mm@*110000=10 mm@*112500=12.5 mm@
CHN	*11=Front sample compartment@*12=Back sample compartment@*13=Back parallel exit@
DTC	*116416=LN-MCT Mid FOV=30° [Internal Pos. 1]@*116417=LN-MCT Mid FOV=30° 4021 [Internal Pos. 1]@*116418=4022 [Internal Pos. 1]@*116448=LN-InSb FOV=30° [Internal Pos. 2]@*116449=LN-InSb FOV=30° DC 4041 [Internal Pos. 2]@*116450=4042 [Internal Pos. 2]@*116576=Classic Style [Internal Pos. 4]@*116577=Classic style DC [Internal Pos. 4]@*116578=Classic style Dual Channel [Internal Pos. 4]@*116704=LHe-Bolometer 4.2K [External Pos. 5]@*116705=Classic Style Ch2 [External Pos. 5]@*116706=Dual Channel! [External Pos. 5]@
FLP	*10=Open flaps@*11=Close flaps@



The *COMBO Cnds* table provides an overview of all available options of the IFS 125HR spectrometer, e.g. Which detectors are installed? Which measurement options (measurement channels etc.) are available?

**Note:** In the first column, the component or parameter is displayed by its corresponding command, e.g. APT means aperture, VEL means velocity. Refer to the *List of Commands*.

The table gives information about all available options for the individual measurement parameters, i.e. the parameters displayed in this table can also be selected in the corresponding OPUS™ dialog window, see the following figure.

For example, the *CHN* (= Measurement Channel) line displays all available options for this parameter. You will also find exactly these parameter options in the OPUS™ *Measurement* dialog, → *Measurement Channel* drop-down list as OPUS™ reads the options available from the optics. See the following figure.

# IFS 125HR SPECIFICATIONS

## General

Parameter	Specification
Optics bench dimension	Optics less scanner: 165 x 80 x 97cm (w x d x h) Scanner: 39 x 114 x 97cm Options: 39 x 171 x 97cm, 39 x 285 x 97cm, 39 x 513 x 97cm
Service unit dimension	30 x 23 x 28cm (w x d x h)
Weight	Optics bench: 600kg Vacuum pump: 75kg Service unit: 5kg
Power consumption	Optics bench: 230V $\pm$ 10%, 50/60Hz, 600W Optional step-up transformer: 115V/230V available  Data system: 120/230V $\pm$ 10%, 50/60Hz, 150W  Vacuum pump: 3PH; 190 - 220 or 380 - 440V, 50/60Hz, 1500W  IFS 125HR is a protection class I product.
Environmental conditions	Operational temperature range: 18°C - 35°C (64 - 95F) Temperature variation: max. 1°C/ per hour and max. 2°C per day Humidity (non-condensing): less than 80% (relative humidity) Installation overvoltage category: II Pollution degree: 2

## Performance

Parameter	Specification
Spectral range	4,800 - 620cm <sup>-1</sup> , option: >50,000-5cm <sup>-1</sup>
Resolution	Better than 0.0063cm <sup>-1</sup> options: 0.0035cm <sup>-1</sup> , 0.0019cm <sup>-1</sup> , 0.001cm <sup>-1</sup>
Resolving power	Better than 10 <sup>6</sup>
Wavenumber accuracy	Better than 5x10 <sup>-7</sup> times wavenumber (absolute), 1x10 <sup>-7</sup> (relative)
Photometric accuracy	0.1% T

## Optics

Parameter	Specification
Design	Modular vacuum cabinets for sources, interferometer, scanner, samples and detectors. Sample chamber is separately evacuable.
Vacuum pump	Double-stage mechanical pump The system is evacuated to $\leq 2 \times 10^{-2}$ hPa.
Sources	Globar, options: mercury lamp, tungsten lamp, xenon arc lamp, emission port
Interferometer	Modified Michelson with 30° angle of incidence, permanently aligned. Nominal beam diameter: 63.5mm
Beam splitter	KBr substrate with multilayer coating, options: Mylar® film, CaF <sub>2</sub> , quartz with different coatings
Scanner	Purely mechanical hybrid bearing with both high resolution and rocking low resolution scan mode. 6 mirror velocities from 0.16 - 2.5cm/sec, mechanical displacement
Field stop	Jacquinot stop with 16 positions from 0.5 - 12.5mm
Gas requirements	Dry air or dry nitrogen with a pressure of 1500hPa is recommended for venting the instrument; connector: DN16KF

Parameter	Specification
Aperture ratio	f/6.5
Sample compartment	Dual channel, access from all slides Beam height: 92mm Focus at sample: 1:1 image of input field stop Dimensions (each channel): 300x250x220mm (w x d x h)
Signal exit ports	Option: up to 2 parallel beam ports from sample compartment and up to 2 parallel beam ports from interferometer compartment for external experiments
Signal input ports	Optional input port for radiation from an external source
Detector	DigiTect™ detector system, liquid N <sub>2</sub> cooled MCT Options: liquid N <sub>2</sub> cooled InSb, DLATGS, silicon diode, UV diode and a variety of other high performance detectors; Up to 4 internal and 2 external detectors can be permanently mounted.
Service units	Closed loop-cooling water supply, vacuum pump

## Electronics

Parameter	Specification
Automation	Remote control of the following devices: aperture wheel with 16 positions, selection between 2 sample channels; Options: selection between 4 sources, optical filter wheel with 8 positions, switching between 4 internal and 2 external detectors, 4 beam exit ports
Amplifier	Pre-amplifier with 4 gain levels, main amplifier with 5 gain levels
A/D converter	24bit, 96kHz Delta-Sigma ADC
Interface to host computer	Ethernet connection with TCP/IP

## Options

<b>Parameter</b>	<b>Specification</b>
Dual channel acquisition	Simultaneous data acquisition from 2 detectors or from a two-color detector

## Software

<b>Parameter</b>	<b>Specification</b>
Spectroscopic software	Analytical software package OPUS, icon-based operation, full GLP compliance

## Data System

<b>Parameter</b>	<b>Specification</b>
PC data system	See separate specification sheet.

# CONSUMABLES

---

<b>Part Number</b>	<b>Description</b>
Q101/2	HeNe laser, frequency stabilized, with power supply
Q202/1	Hg arc lamp
Q302	Globar, internal, 24V/150W
Q400	Tungsten source mount
Q403	Tungsten source for NIR applications, 12V/50W
Q501	Tungsten lamp, 12V/50W (set of 5 pieces), for VIS applications
Q602-R	UV source (Xenon lamp), replacement source (75W)

For optional spectrometer configurations and accessories refer to the current price list which can be requested on demand.



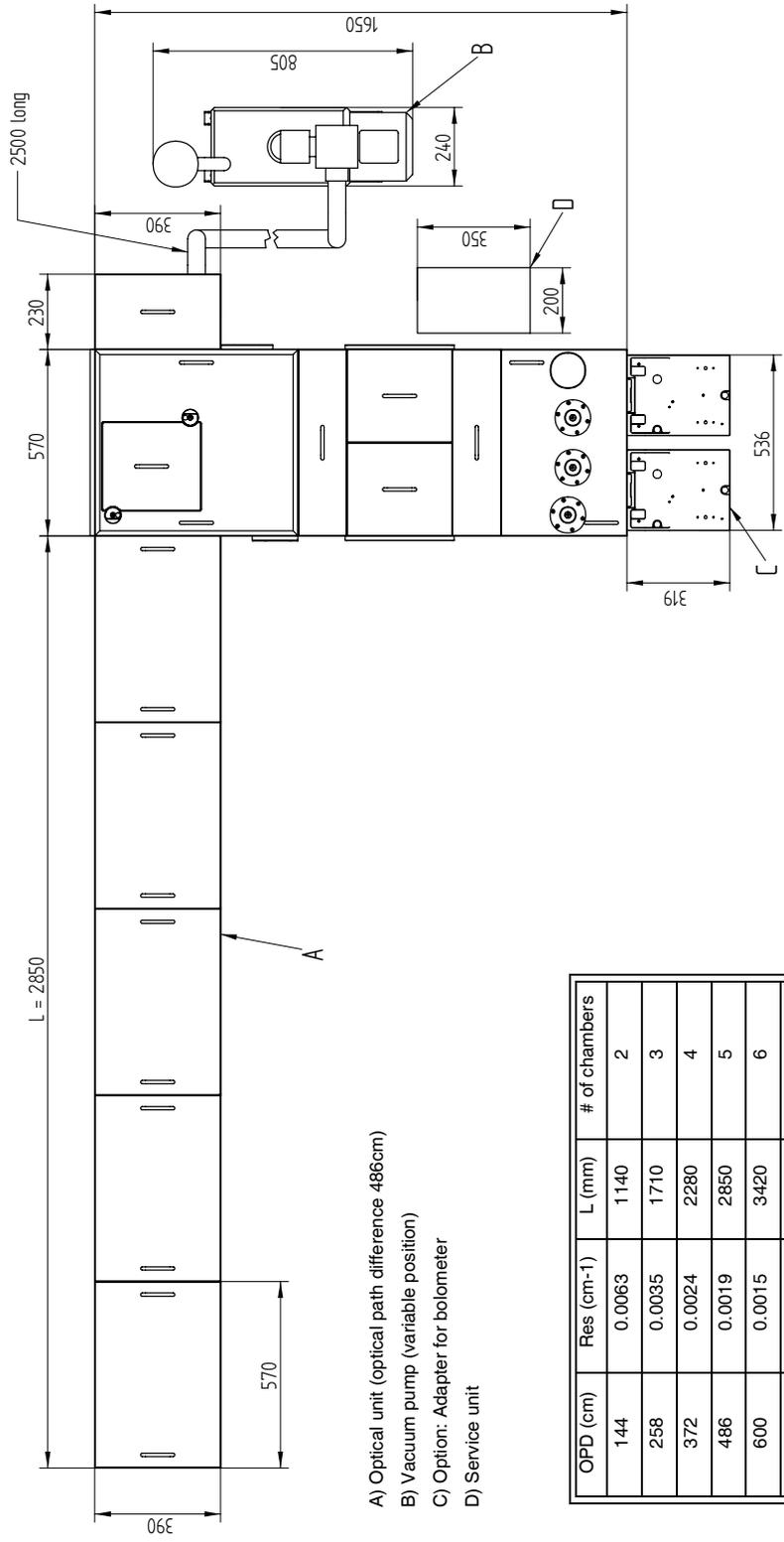
# DEFAULT PARAMETER SETTINGS

Data acquisition is performed and automated by the OPUS™ application software. The following table includes parameters recommended for the standard spectrometer configuration (MIR). Note that depending on the spectrometer configuration, different default parameter settings may apply. Select the *Select Measurement Parameters* command in the OPUS™ *Measure* menu and enter the following measurement parameters on the different tabs:

<b>Advanced Parameters</b>	<b>Settings</b>
Resolution	2
Sample/Background Scans	32
Save Data	0 to 7000
Result Spectrum	Transmittance
Data Blocks to be saved	Single Channel/Sample Interferogram
<b>Optics Parameters</b>	<b>Settings</b>
Source Setting	MIR
Beam Splitter	KBr (MIR)
Optical Filter Setting	Open
Aperture Setting	1.5mm
Sample/Background Measurement Channel	Front sample compartment
Detector Setting	LN-MCT [Internal Pos. 1]
Scanner Velocity	40kHz
Sample/Background Signal Gain	x1
Delay after Device Change	0 sec
Delay before Measurement	0 sec
<b>Acquisition Parameters</b>	<b>Settings</b>
Wanted High Frequency Limit	15,500cm <sup>-1</sup>
Wanted Low Frequency Limit	0cm <sup>-1</sup>
High Pass Filter	Open

Low Pass Filter	40kHz
Acquisition Mode	Single Sided, Forward/Backward
Correlation Mode	Off
<b>FT Parameters</b>	<b>Settings</b>
Phase Resolution	4
Phase Correction Mode	Mertz
Apodization Function	Blackman-Harris 3-Term
Zerofilling Factor	2

# DIMENSIONAL DRAWINGS



- A) Optical unit (optical path difference 486cm)
- B) Vacuum pump (variable position)
- C) Option: Adapter for bolometer
- D) Service unit

OPD (cm)	Res (cm-1)	L (mm)	# of chambers
144	0.0063	1140	2
258	0.0035	1710	3
372	0.0024	2280	4
486	0.0019	2850	5
600	0.0015	3420	6
714	0.0013	3990	7
828	0.0011	4560	8
942	0.00096	5130	9

Figure 52: IFS 125HR - Top view

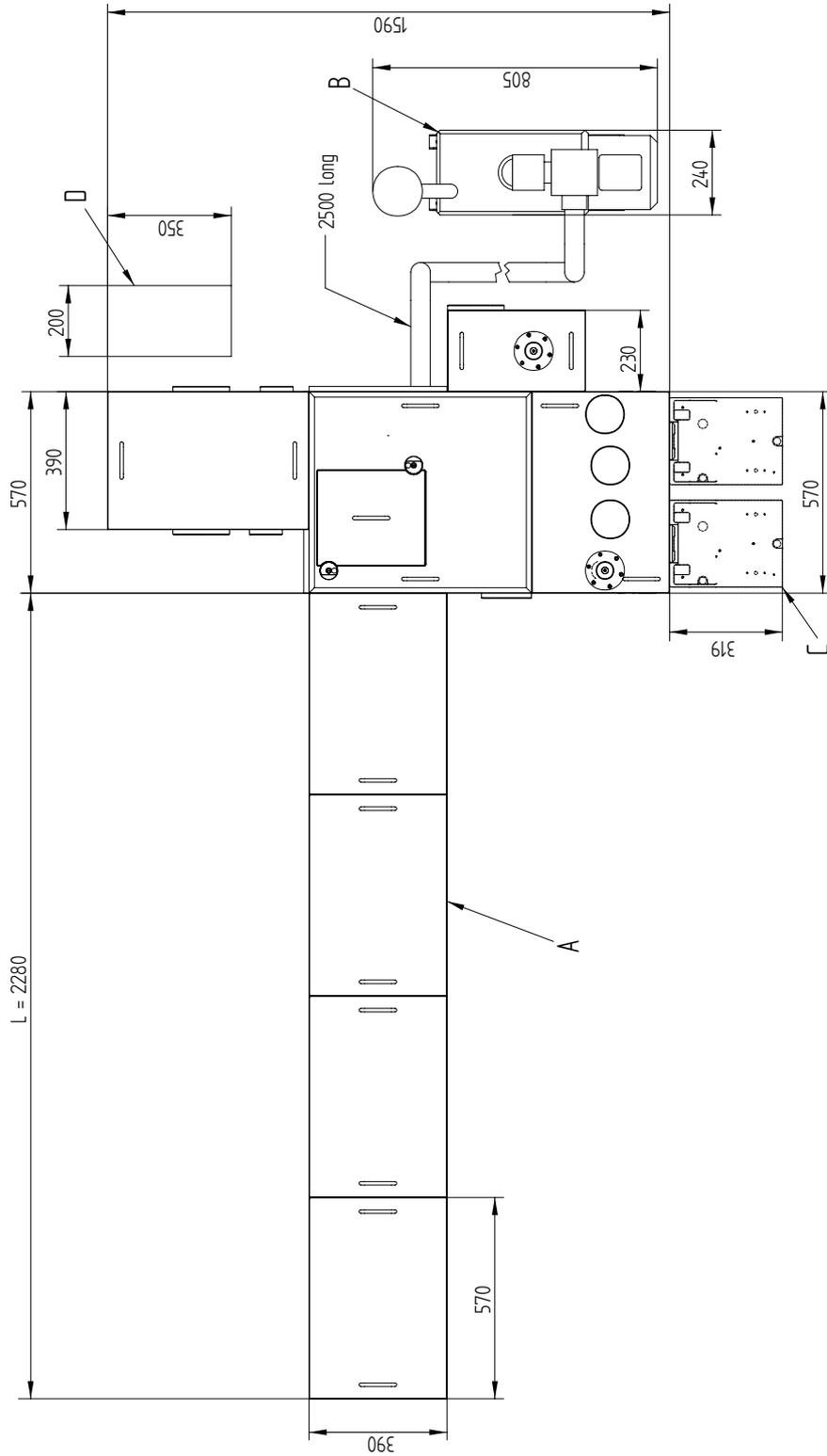


Figure 53: IFS 125HR - Top view with large source compartment and without sample compartment

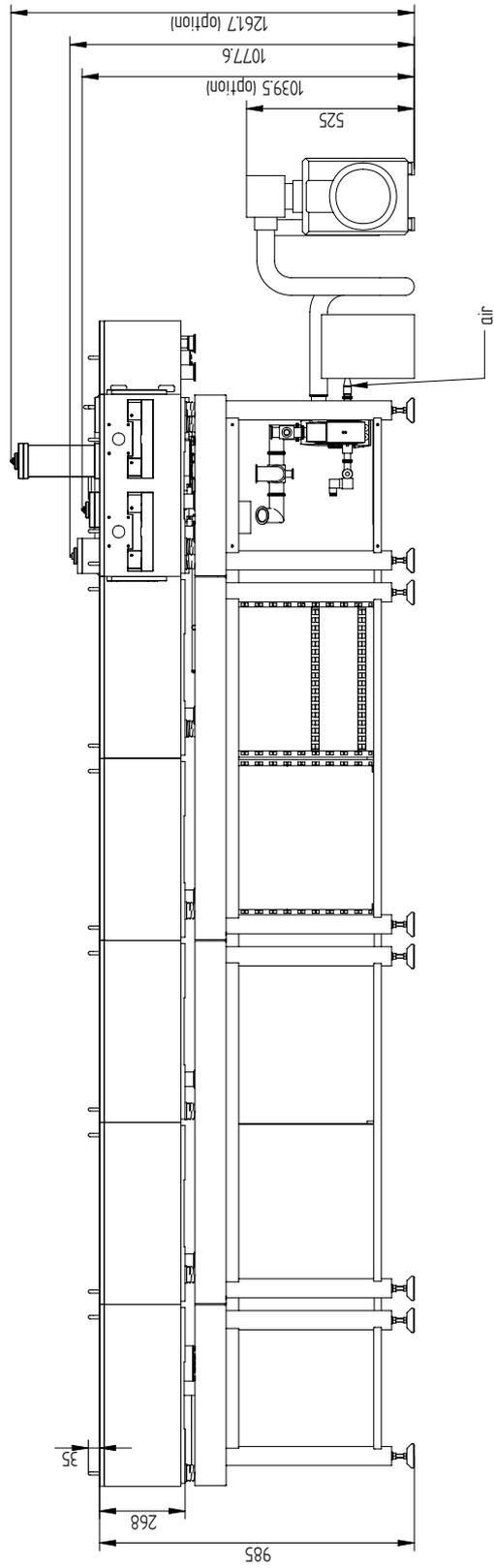


Figure 54: IFS 125HR - Front view

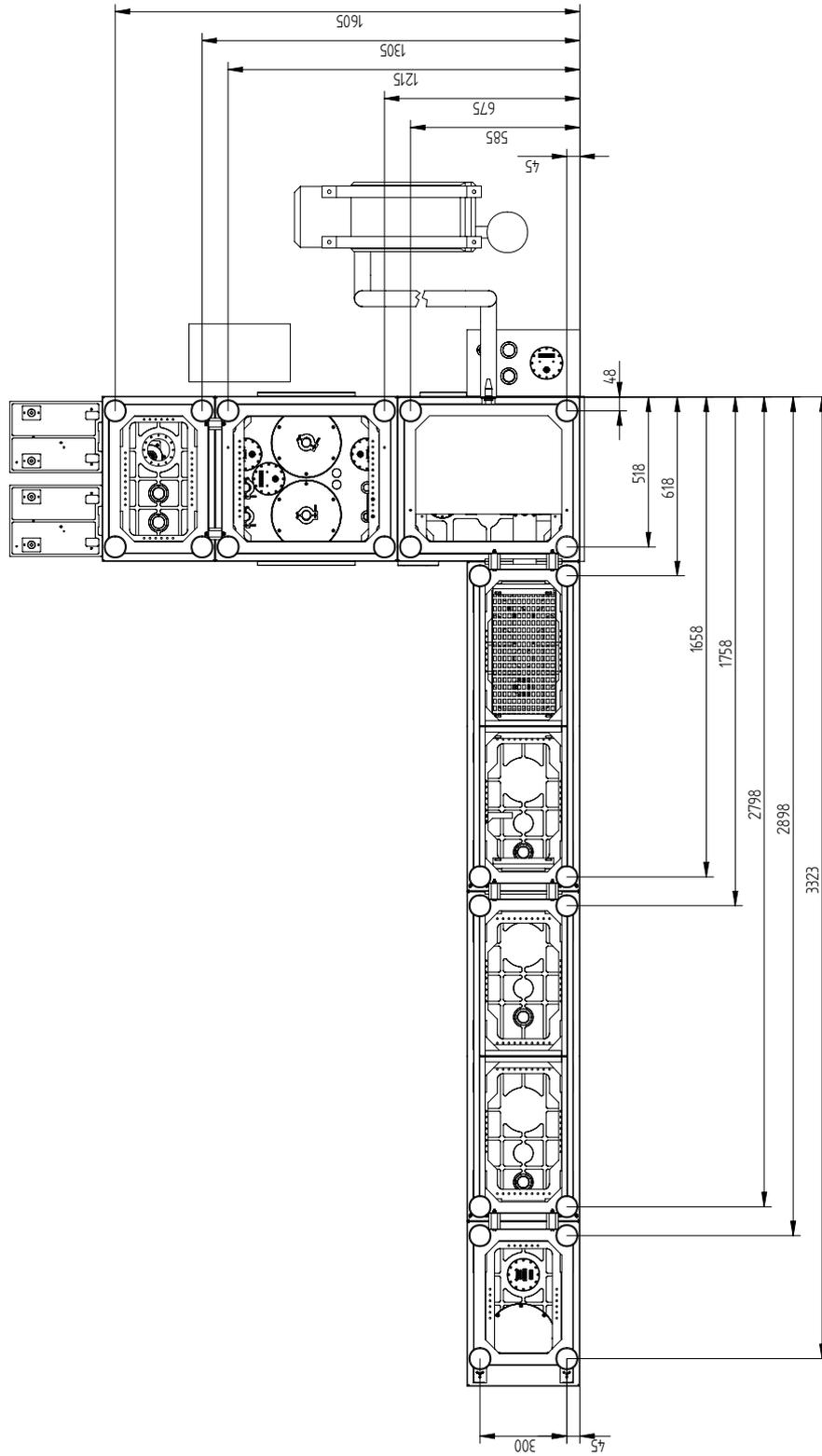


Figure 55: IFS 125HR - Bottom view showing location of feet, 5-chamber system

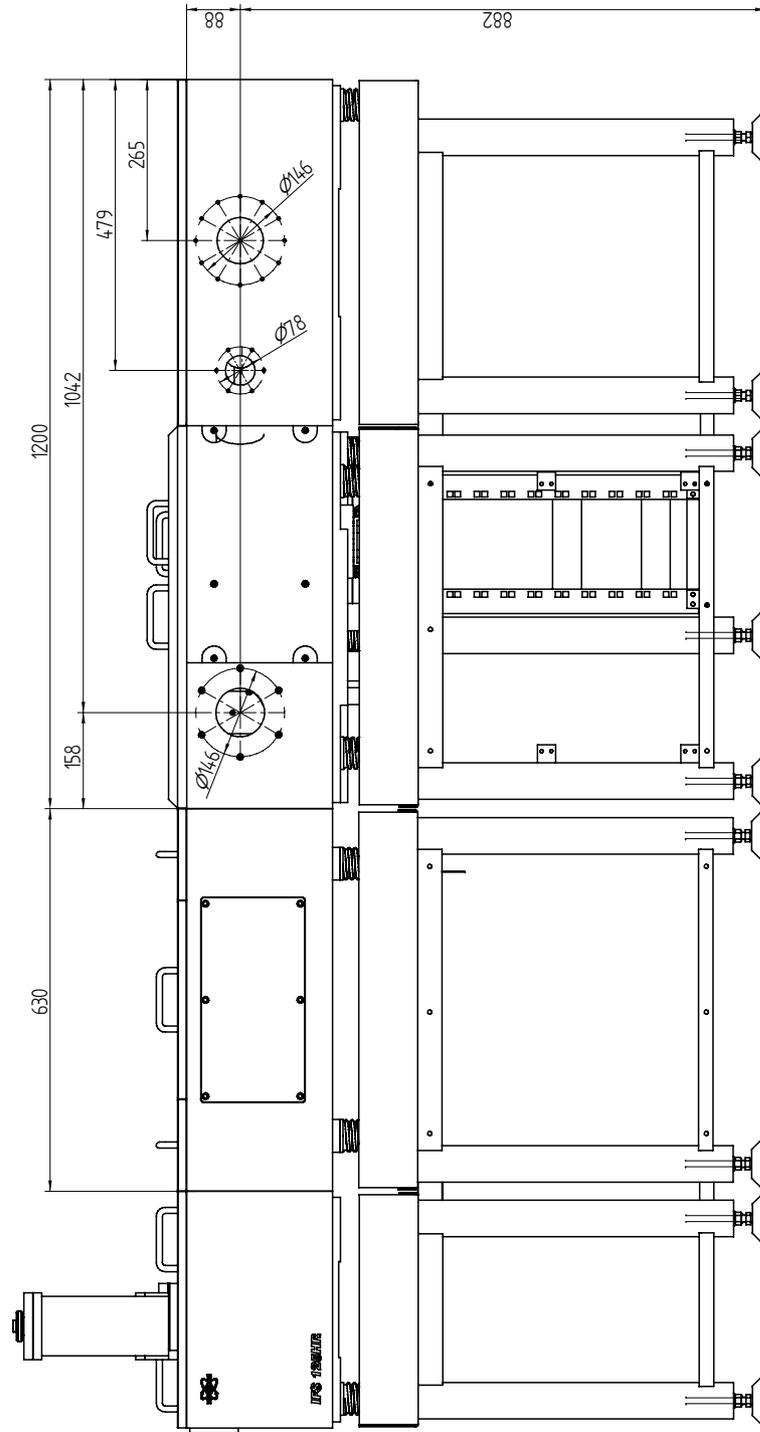


Figure 56: IFS 125HR - Port location left side

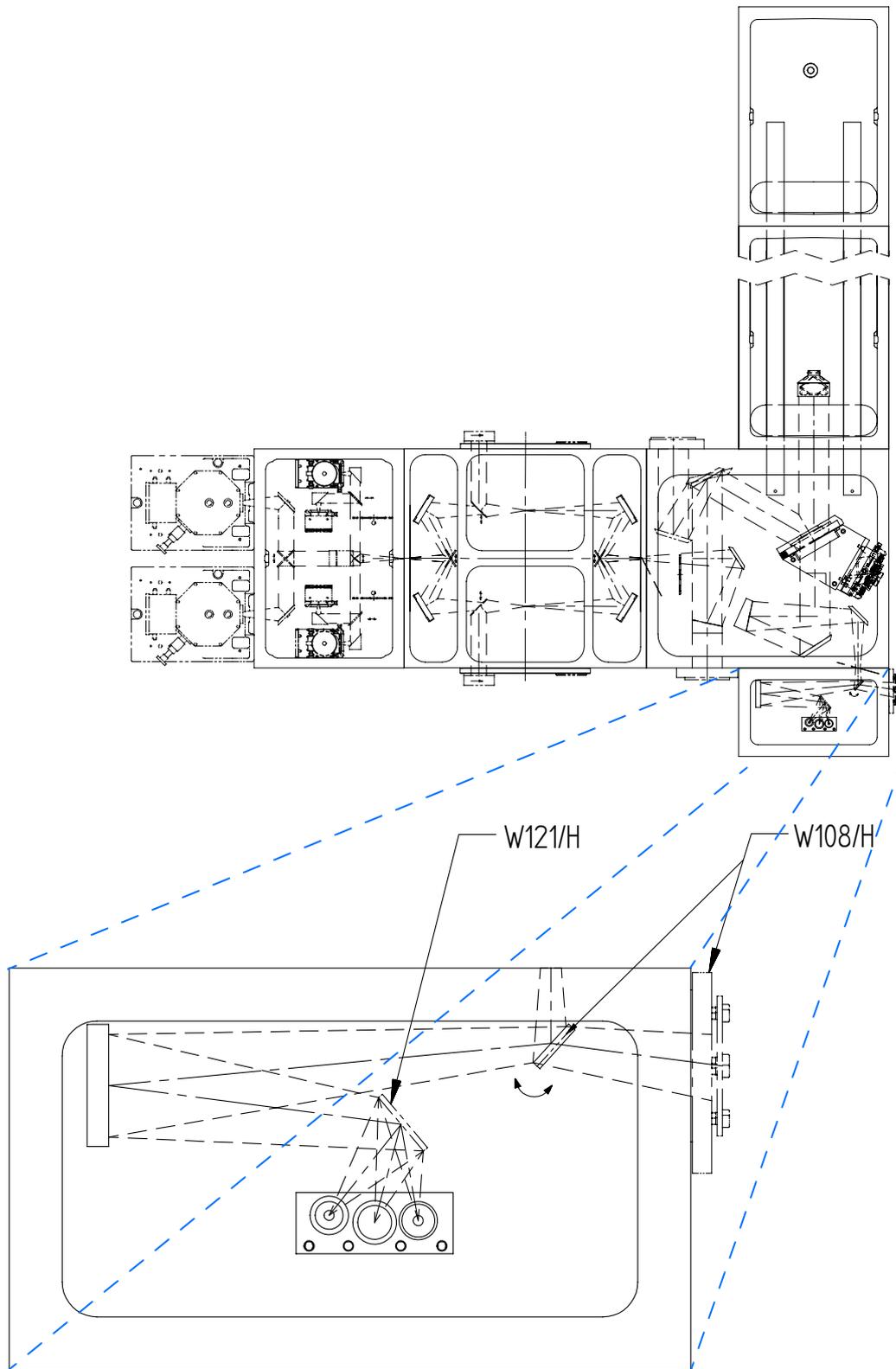


Figure 57: IFS 125HR - Standard source chamber

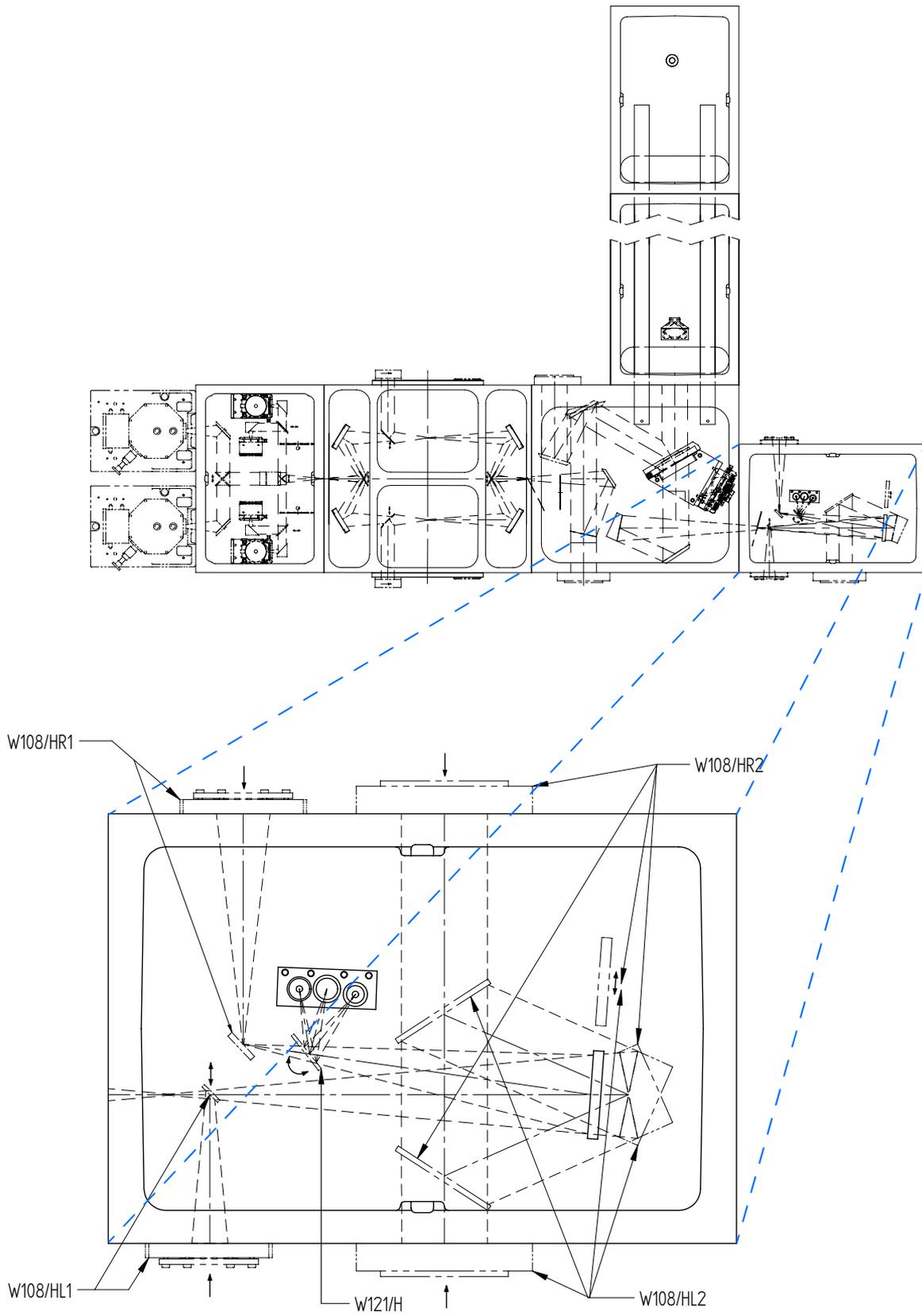


Figure 58: IFS 125HR - Large source chamber

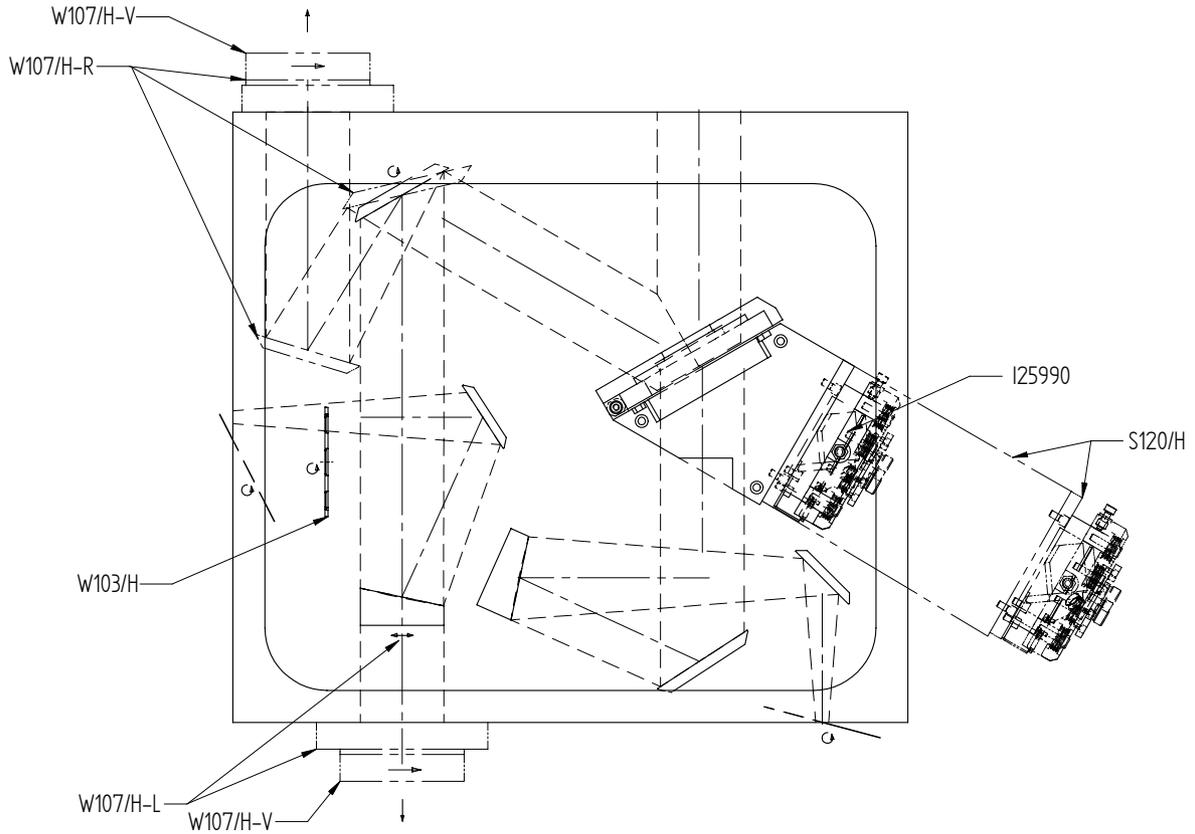


Figure 59: IFS 125HR - Interferometer chamber

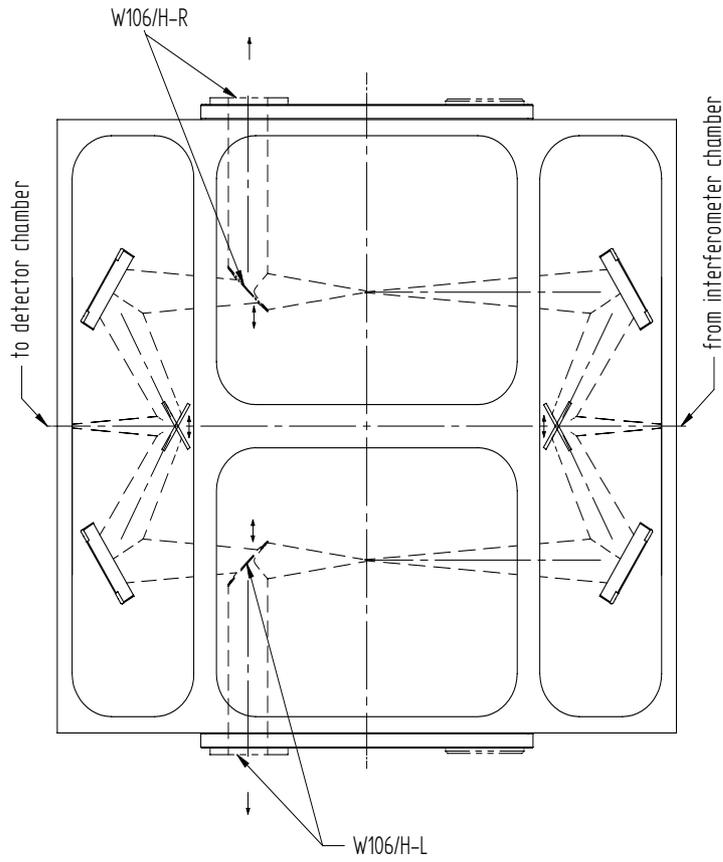


Figure 60: IFS 125 HR - Sample chamber options

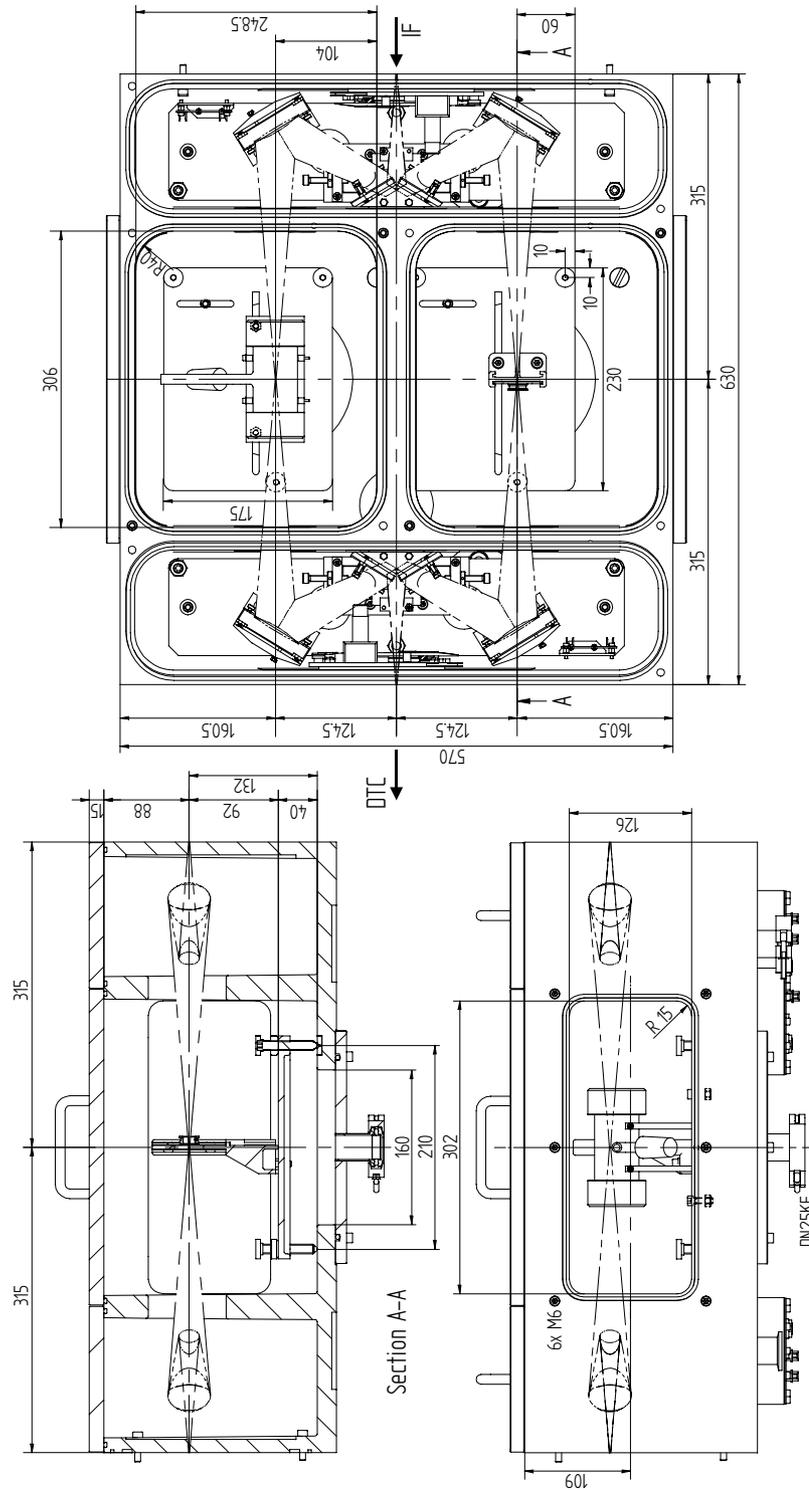


Figure 61: IFS 125HR - Sample chamber

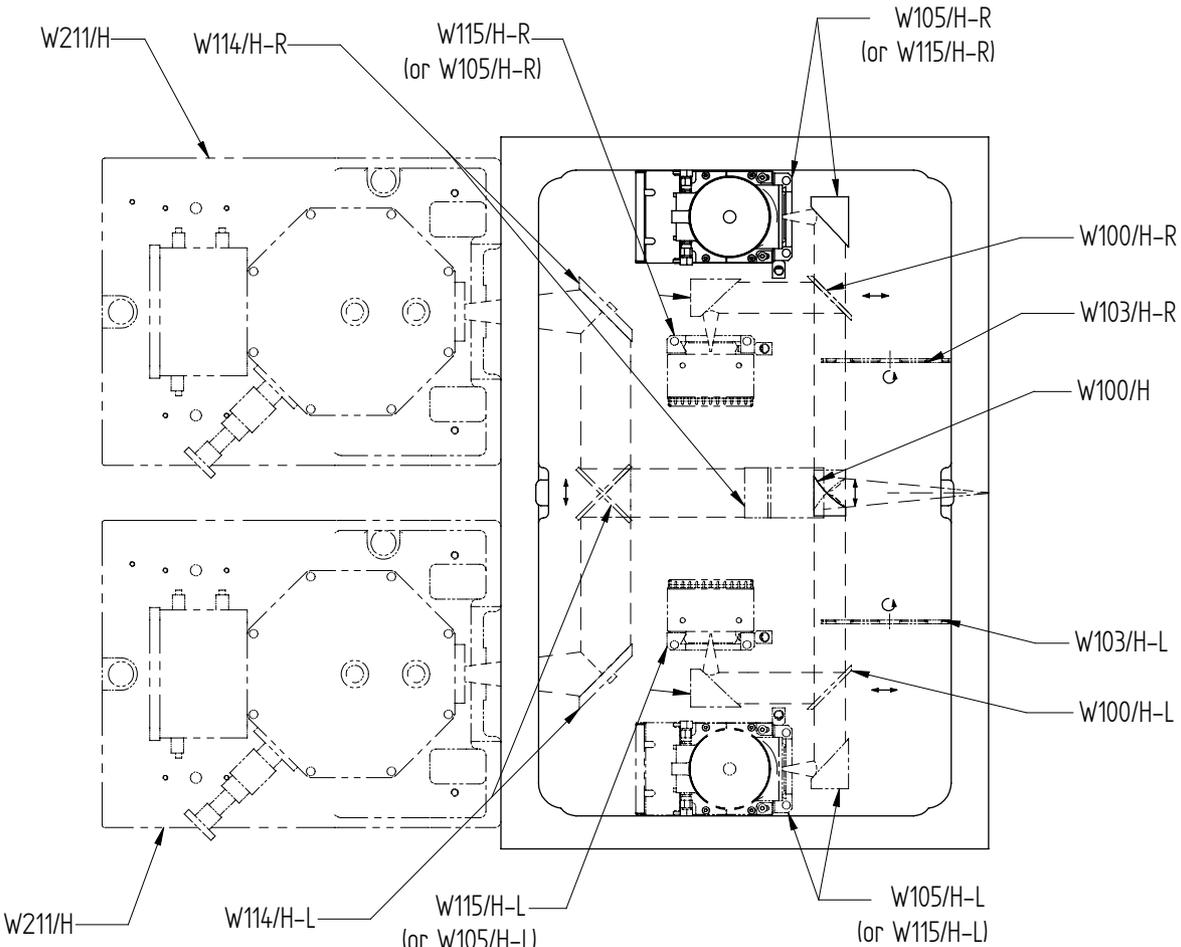


Figure 62: IFS 125 HR - Detector compartment



# CONNECTING IFS 125HR TO A PC

To connect the IFS 125HR spectrometer to the computer on which the OPUS™ software runs you have to perform the following steps:

- 1 Selecting a connection topology
- 2 Defining an appropriate network address
- 3 Assigning network addresses
- 4 Checking the connection

## SELECTING A CONNECTION TOPOLOGY

The diagrams below illustrate the RJ-45 Ethernet cable wiring for a standard and cross-over cable.

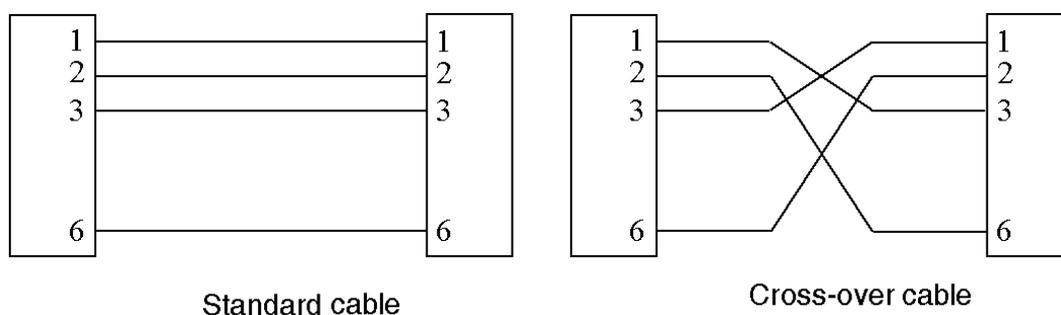


Figure 63: RJ-45 Ethernet cable wiring

In general, you can select between the following connection topologies.

### a) Stand-alone configuration (standard configuration):

In case of IFS 125HR this is the preferred topology. Other configurations may lead to data loss or longer acquisition time.

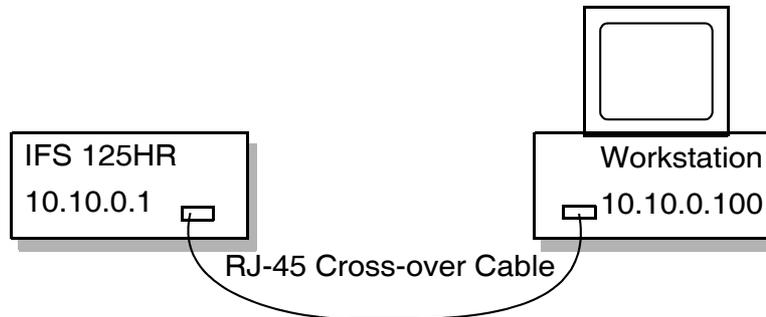


Figure 64: IFS 125HR stand-alone configuration

IFS 125HR is directly connected to the PC, and neither the PC nor the spectrometer is connected to a network. This connection type requires a cross-over cable which will be supplied with the spectrometer.

#### Advantages:

- Easy to install
- Full bandwidth available for data transfer between IFS 125HR and the PC
- No access problems with other workstations which also try to access IFS 125HR
- No data transfer rate problems

#### Disadvantages:

- No remote access to IFS 125HR from other workstations on which the OPUS™ software is installed
- No network connection for the computer
- Local printer required to print out measurement results

## b) Connecting IFS 125HR and workstation to a network:

If you use this configuration in connection with IFS 125HR, you have to observe the following:

**Note:** Make sure that the required data rate is continuously provided (approx. 5MBit/sec) as any network transfer rate limitation can cause the measurement to be irreversibly damaged.

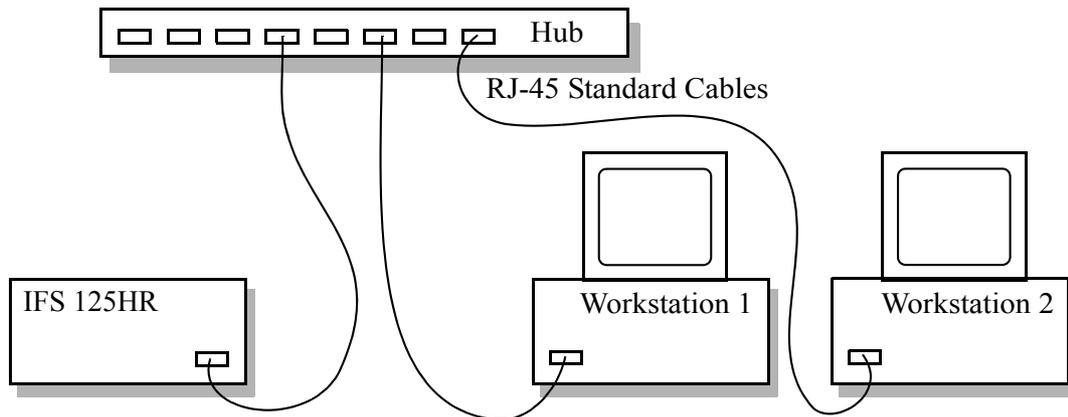


Figure 65: Integrating IFS 125HR into an Ethernet 10Base-T network

In this configuration, both the spectrometer and the workstation on which the OPUS™ is installed are directly connected to the network.

### Advantages:

- Remote access to IFS 125HR via internet or intranet is possible.
- The workstation can access all network resources (provided you have the corresponding access rights).

### Disadvantages:

- Your network administrator must be involved in configuring the connection.
- To connect the spectrometer to the workstation requires a different 10Base-T cable than the one delivered with IFS 125HR. Ask your network administrator for a standard (not a cross-over) CAT5 10Base-T cable with a RJ-45 plug.
- Only a small range of the bandwidth is available for the data transfer between IFS 125HR and the workstation. The measurement time may increase due to data transmission delays. If the average transfer rate is less than the required transfer rate, the buffer in the optics controller will eventually overflow and the measurement will be damaged.
- Possible access problems caused by other workstations which also try to access IFS 125HR.

### c) Connecting IFS 125HR to a network computer:

If network support is required, this is the preferred topology in case of IFS 125HR.

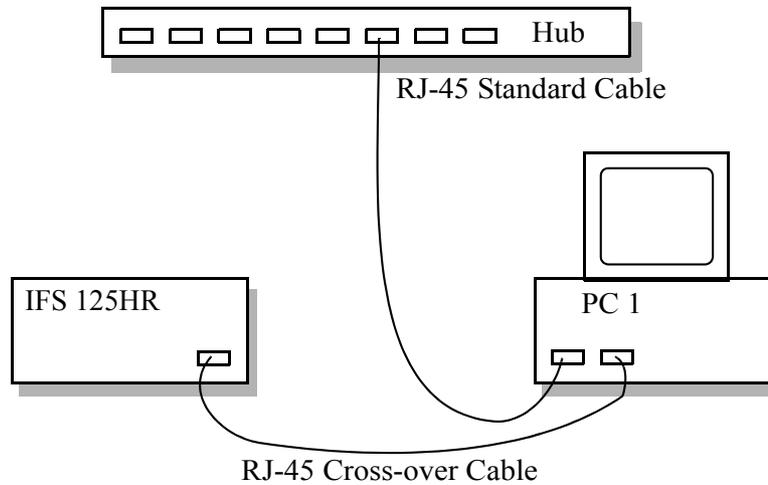


Figure 66: Integrating IFS 125HR into an Ethernet 10Base-T network via a PC

This topology combines the advantages of the first two configurations, but requires additional hardware and is the most difficult one to install.

#### Advantages:

- Full bandwidth is available for the data transfer between IFS 125HR and the PC.
- Remote access to IFS 125HR via internet or intranet is possible (provided you have the corresponding access rights).
- The PC can access all network resources (sufficient permissions assumed).
- Different data transfer rates for the data exchange between IFS 125HR (10Base-T) and the network connection (no restrictions) are possible.

#### Disadvantages:

- Your network administrator must be involved in configuring the connection.
- Second network interface card is required for the PC which controls the spectrometer.



# DEFINING AN APPROPRIATE NETWORK ADDRESS

---

When delivered, IFS 125HR has already been configured for stand-alone operation (provided you have also acquired a PC). In this case, you only have to connect the spectrometer and the PC using a cross-over cable.

Depending on the connection topology, use the following IP addresses:

## a) IP addresses for standard configuration:

IFS 125HR:	IP address	10.10.0.1
	Subnet Mask	255.255.0.0
	Gateway	0.0.0.0
Workstation:	IP address	10.10.0.100
	Subnet Mask	255.255.0.0
	Gateway	0.0.0.0

**Note:** Do not specify a Gateway when using Windows™ 2000 or XP as operating system!

## b) IP addresses for connecting IFS 125HR and the PC to a network:

This configuration requires a unique IP address, both for the spectrometer and the PC. These addresses depend on your intranet and must be assigned by your network administrator. To be able to have access to IFS 125HR via internet you also have to specify a gateway address. The gateway links your intranet domain to other domains (e.g. domains being part of the internet). Otherwise, you should set the gateway address to 0.0.0.0 or leave the field empty when using Windows™ 2000 or XP as operating system.

**Note:** A wrong IP address may interfere with other devices connected to the network.

## c) IP addresses for connecting IFS 125HR to a network computer

This configuration requires 2 network interface cards and 3 set of addresses. The first set is determined for the spectrometer, the second for the network interface card communicating with the spectrometer and the third for the network interface card linking the computer to the intranet.

IFS 125HR:	IP address	10.10.0.1
	Subnet Mask	255.255.0.0
	Gateway	0.0.0.0

**Note:** Do not specify a Gateway when using Windows™ 2000 or XP as operating system!

PC and network interface card connected to the spectrometer:

	IP address	10.10.0.100
	Subnet Mask	255.255.0.0
	Gateway	0.0.0.0

**Note:** Do not specify a Gateway when using Windows™ 2000 or XP as operating system!

PC and network interface card connected to the network/hub:

	IP address	Assigned by your network administrator
	Subnet Mask	Assigned by your network administrator
	Gateway	Assigned by your network administrator

## ASSIGNING NETWORK ADDRESSES

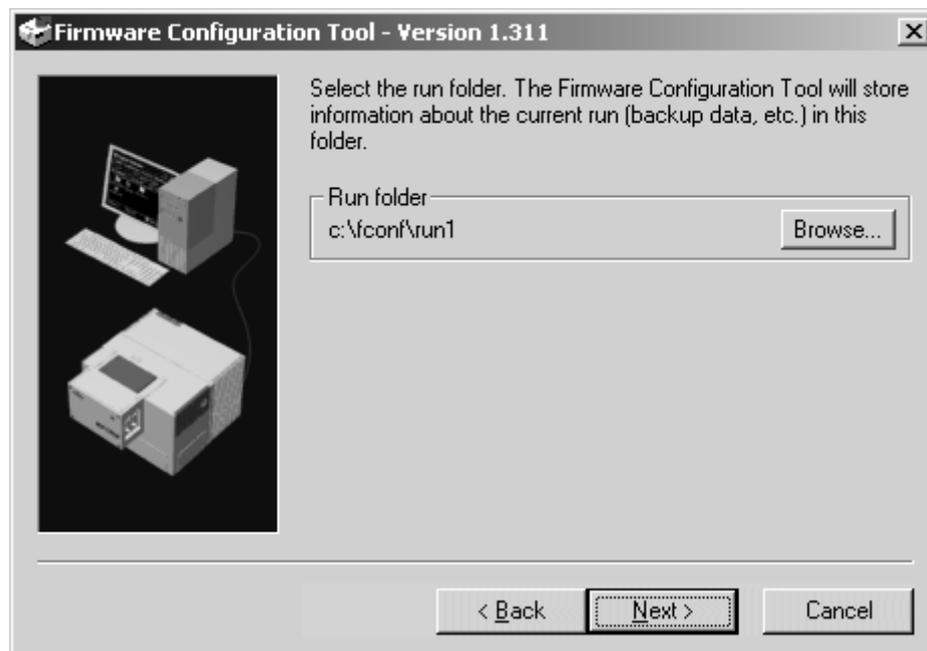
This section describes how to assign an IP-address to an instrument which has not yet been configured, using the FCONF program. The program is part of the OPUS™ software and can be found in the OPUS™ directory or directly on the OPUS™ CD.

The FCONF program is also used to update the spectrometer by the latest firmware versions. Therefore, some program options are not relevant to assigning of IP addresses, and will not be described in this manual.

- Start the FCONF program<sup>1</sup>. The following dialog opens:



- Activate the *Modify IP settings* option button and click on the *Next* button.

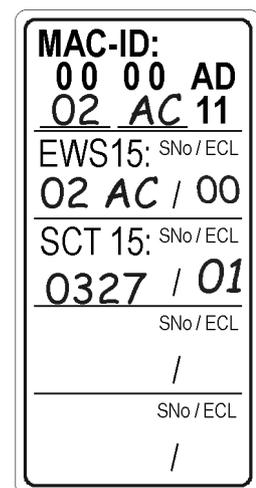
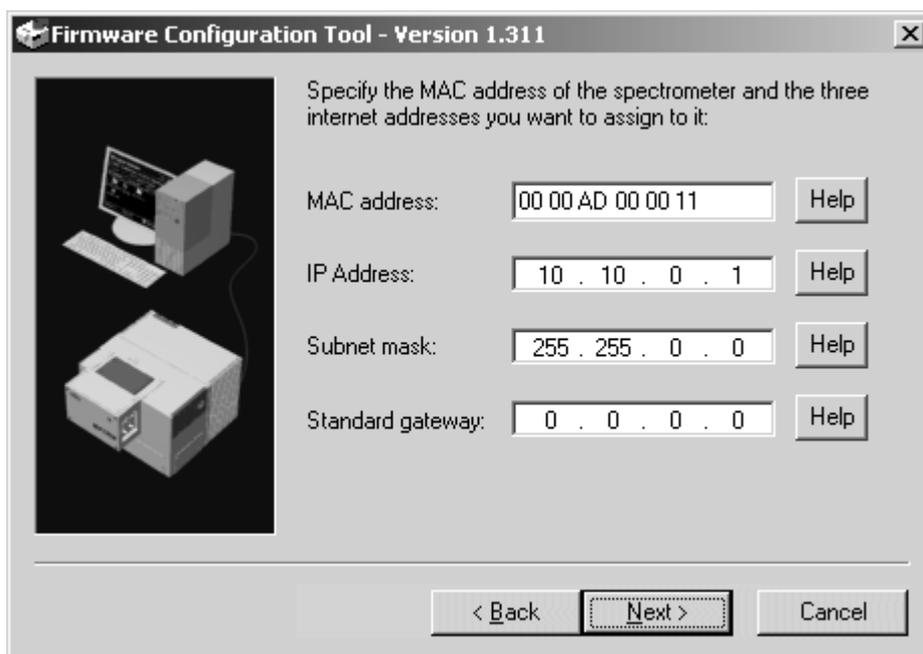


1. You must have administrator rights in order to run the program successfully.

- Accept the settings and click on the *Next* button.



- Activate the *Assign a new address to the spectrometer* option button and click on the *Next* button.
- The IP address assignment dialog opens:

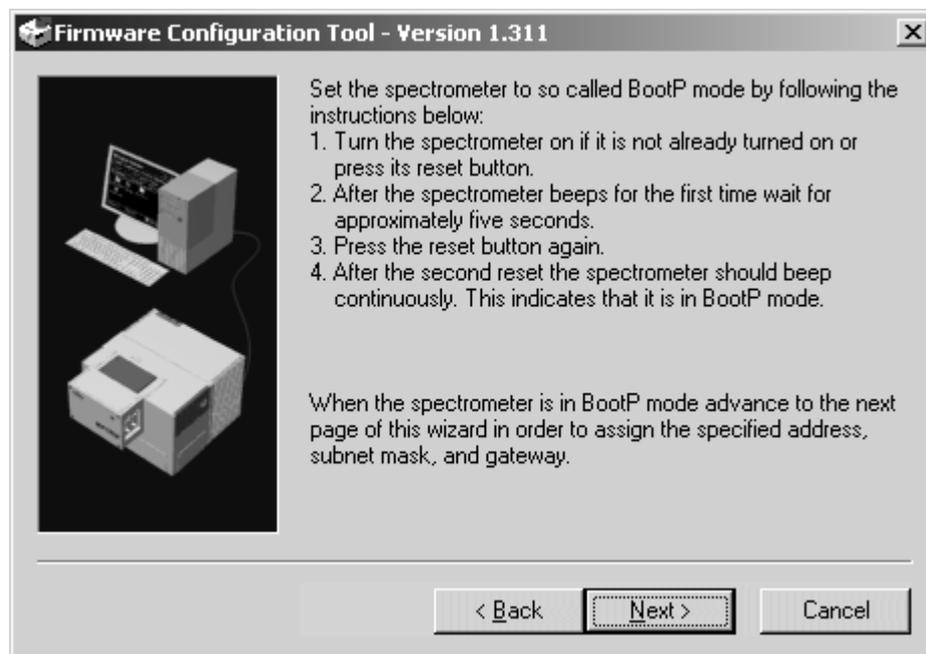


- Specify the MAC address (Media Access Control address), IP and gateway address. The *Help* buttons provide additional information on how to fill in the different lines.

- The MAC address is the unique hardware name of the network interface adapter installed inside the spectrometer. You will find this address on the label at the front panel of the electronics unit (see figure above). In this example, the MAC address is 00 00 AD 02 AC 11. Enter this code into the *MAC address* entry field of the IP address assignment dialog.
- If this label is missing or the MAC address proves to be incorrect, you will also find this address on a label inside the electronics unit. It is located on a black 26-pole connector at the EWS15-board.

**Note: Always keep the MAC address on the label up to date! A wrong MAC address will lead to confusion. Make sure that the label with the correct MAC address is on the spectrometer electronics panel.**

- The entries for the remaining three entry fields of the dialog depend on the connection topology selected. For more information, also see *Defining an appropriate network address* on page E - 4. The default entries are shown in the figure above and should be used for the direct connection from the spectrometer to the PC. If you have entered all the necessary data, click on the *Next* button.
- Now, you will be asked to set the spectrometer into BootP-mode. Follow the on-screen instructions.



**Note: The Reset button is on the electronics panel, see figure 67 on page 147.**

- When the instrument is in BootP mode, click on the *Next* button to start the procedure. Otherwise, the BootP-mode will automatically be terminated after 2 minutes.
- The assigning procedure starts immediately and may take several minutes.

- After a successful completion, a message will be displayed and the spectrometer automatically reboots.
- Now, the spectrometer starts up with the newly-assigned IP settings and can be accessed by the computer.

## CHECKING CONNECTION

---

To check the connection you can use either the Internet Explorer provided as part of Windows™, or any other Internet browser program installed on the PC.

Proceed as follows:

- 1 Power up IFS 125HR.
- 2 Wait about 1.5 minutes to allow IFS 125HR to boot. A dark or flashing SR LED indicates that the boot process is completed.
- 3 Start the Internet browser.
- 4 Make sure that the internet browser is not off-line. In case of the Microsoft Internet Explorer the off-line mode is activated if the *Offline Mode* command in the *File* menu of the browser is checked.
- 5 Ensure that the internet browser does not use a proxy server, or at least not in case of addresses of direct access in the 10.10.x.x.-range. If you use the Microsoft Internet Explorer, you can check this by selecting the *Internet Options* command in the *Extra* browser menu. Click on the *Connections* tab and on the *Settings* button in the *LAN-Settings* group field.
- 6 Enter the IFS 125HR IP address into the browser address field (for stand-alone configuration: 10.10.0.1) designed for the start page.
- 7 Click on the *Enter* button.

Now the Internet Explorer should display the IFS 125HR spectrometer homepage.

If the Internet Explorer shows a blank page and is not able to access the IFS 125 HR homepage, check the IP address you have just assigned for correct spelling. If the problem still persists, refer to chapter 7 for troubleshooting.

# ELECTRONICS AND POWER SUPPLY

## ELECTRONICS PANEL

The electronics panel includes cable connections (e.g. Ethernet connection) and LEDs which serve for the instrument diagnostics. Each LED indicates a specific operating status, e.g. interferometer mirror movement, data transfer etc.

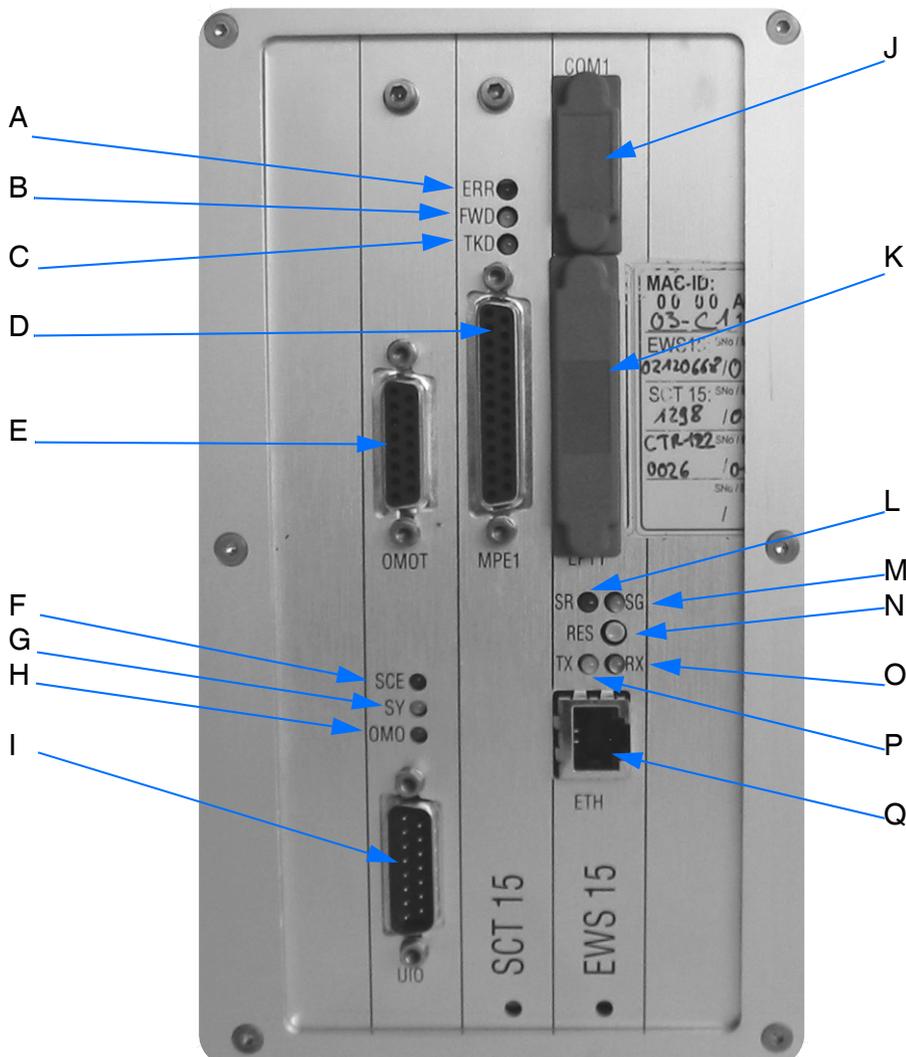


Figure 67: IFS 125HR - LEDs and cable connectors

## ERR LED

The red ERR LED (A in figure 67) indicates an interferometer error, e.g. a missing laser signal. As long as this LED lights, no data acquisition is possible. See chapter 7 for troubleshooting. The ERR abbreviation means *Error*.

## FWD LED

The yellow FWD LED (B in figure 67) indicates the current interferometer mirror movement. As long as the interferometer mirror moves forward this yellow LED lights. During the backward movement the LED does not light. Thus, the LED flashes in the rhythm of the interferometer mirror forward and backward movement. This rhythm depends on the measurement parameters selected (e.g. resolution and velocity). When data acquisition actually takes place the light intensity changes to bright yellow. The FWD abbreviation means *Forward*.

## TKD LED

The green TKD LED (C in figure 67) indicates that the interferometer mirror is within the data acquisition range. Typically, it flashes with twice the frequency and synchronous to the FWD LED. When data acquisition actually takes place the light intensity changes to bright green. The TKD abbreviation means *Take Data*.

## MPE 1 PORT

The MPE 1 (D in figure 67) is a versatile port to connect external optical modules and detectors. It includes a complete CAN-Bus, transmits all required remote trigger signals and establishes a complete connection to DDC (Digital Detector Connection) compatible detectors.

## OMOT PORT

The OMOT port (E in figure 67) controls the outer scanner motor. It is connected to the last scanner compartment. The OMOT abbreviation means *Outer Motor*.

## SCE LED

If the SCE LED (F in figure 67) is in the OFF, the spectrometer status is OK. The SCE LED continuously lights if one of the following problems occurred:

- Front or back end switch has been activated.
- Cord has been torn.
- Beam splitter door is open.
- Outer encoder is not adjusted.
- Light switches are not connected.
- Laser is not ready.

## SY LED

The yellow SY LED (G in figure 67) is an LED for functions not yet defined.

## OMO LED

The OMO LED (H in figure 67) indicates the operating status of the outer scanner motor. If the LED lights green, the outer motor is powered and the scanner performs in the long-scan mode. If the LED is OFF, the outer motor stops and the scanner performs in the short-scan mode.

## UIO PORT

The user I/O port (I in figure 67) is a future expansion port for functions not yet defined. The UIO abbreviation means *User Input/Output*.

## COM1 PORT

The COM1 port (J in figure 67) is similar to a conventional, PC-compatible serial port. It is only used for special applications.

## LPT1 PORT

The LPT1 port (K in figure 67) is reserved for diagnostics. **Do not connect any device to this port!** The LPT abbreviation means *Line Printer*.

## SR LED AND SG LED

The red SR and green SG LED (L and M in figure 67) indicate the internal operating status of the spectrometer communication processor. The SR LED lights red during the boot process. Communication via Ethernet is not possible before the SR LED turns off. See chapter 7 for troubleshooting. The abbreviation SR means *Status Red*, and SG means *Status Green*.

## RES BUTTON

The spectrometer is equipped with a reset button (N in figure 67) which is similar to the one known from a PC. If you press this button for more than 1 second, the spectrometer will be reset without the need to turn it off. The effect is identical to switching the spectrometer off and on again. Additionally, this button is used when assigning an IP address to the spectrometer. For further details, see appendix E.

## TX LED AND RX LED

These LEDs (O and P in figure 67) indicate the data transfer between the spectrometer and the data system via the Ethernet connection. In case of the stand-alone configuration, the green RX LED indicates that the spectrometer receives data. If the spectrometer is connected to an Ethernet network, the green RX LED indicates that data are transmitted on the Ethernet (this does not necessarily mean that the data are determined for the spectrometer).

The yellow TX LED lights if the spectrometer transmits data. This indicates that the spectrometer is accessed by a computer.

**Note:** Use these LEDs to test the operational reliability of the Ethernet connection.

## 10 BASE T ETHERNET PORT

The ETH connector (Q in figure 67) is primarily used to connect the spectrometer to a computer on which the application software (e.g. OPUS™) is installed. The spectrometer can be connected either to a 10Base-T intranet or directly to the computer using a cross-over cable (stand-alone configuration). This is a standard cable in which the TX and RX lines are cross-linked.

A standard IFS 125HR spectrometer is pre-configured by Bruker for stand-alone operation. The IP address is labeled on the electronics unit front side (D in figure 68). The ETH port is designed for RJ-45 plugs and complies with the 10Base-T standard. Use a CAT-5 SFTP cable for the connection and make sure that the cable length does not exceed 100 meters. Alternatively, a gateway can be used to connect the spectrometer to the internet. In this case IFS 125HR must have a unique IP address. For details on how to assign IP addresses, refer to appendix E.

**Note:** Be aware that the interface speed is 10Mbit/s. In this case a pure 100BASE-T connection does not work.

## POWER SUPPLY PANEL

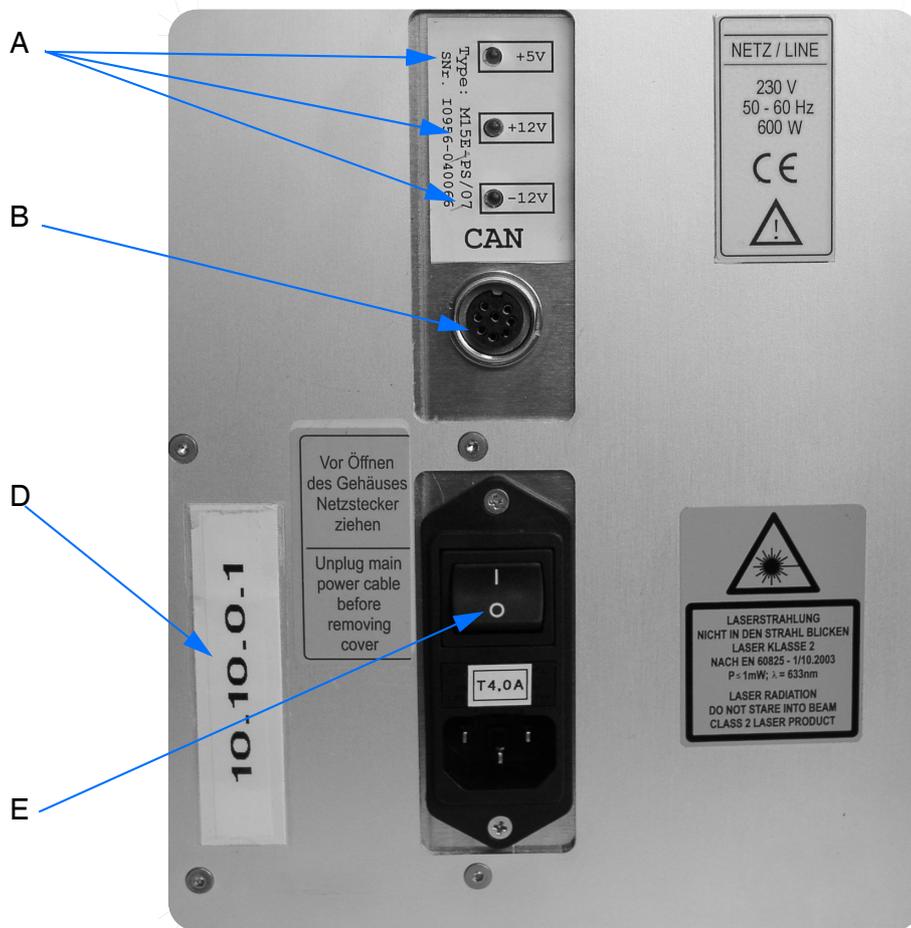


Figure 68: IFS 125HR - ELU power switch and CAN Bus connector

### POWER LEDS +5V, +12V, -12V

These LEDs (A in figure 68) indicate the status of the secondary voltages of the power supply unit.

**Note:** Any dark power supply LED indicates a major problem with the spectrometer electronics.

## CAN BUS CONNECTOR

The CAN connector (B in figure 68) is primarily used to communicate with external automated units, e.g. sample changers, moving mirror units. The CAN bus also supplies power to these units. Thus, most external units can be operated without connecting them to the power supply. Furthermore, the bus can be used as a communication link to control self-supplied external units via IFS 125HR.

## ELU POWER SWITCH

The power switch (C in figure 33) is used to switch the electronics unit on and off. This switch interrupts the primary line voltage of the electronics unit only. The ELU abbreviation means *Electronics Unit*.

## IP ADDRESS

The spectrometer has a unique IP address (D in figure 68). For details on how to assign IP addresses, refer to appendix E.

## FLANGE PANEL

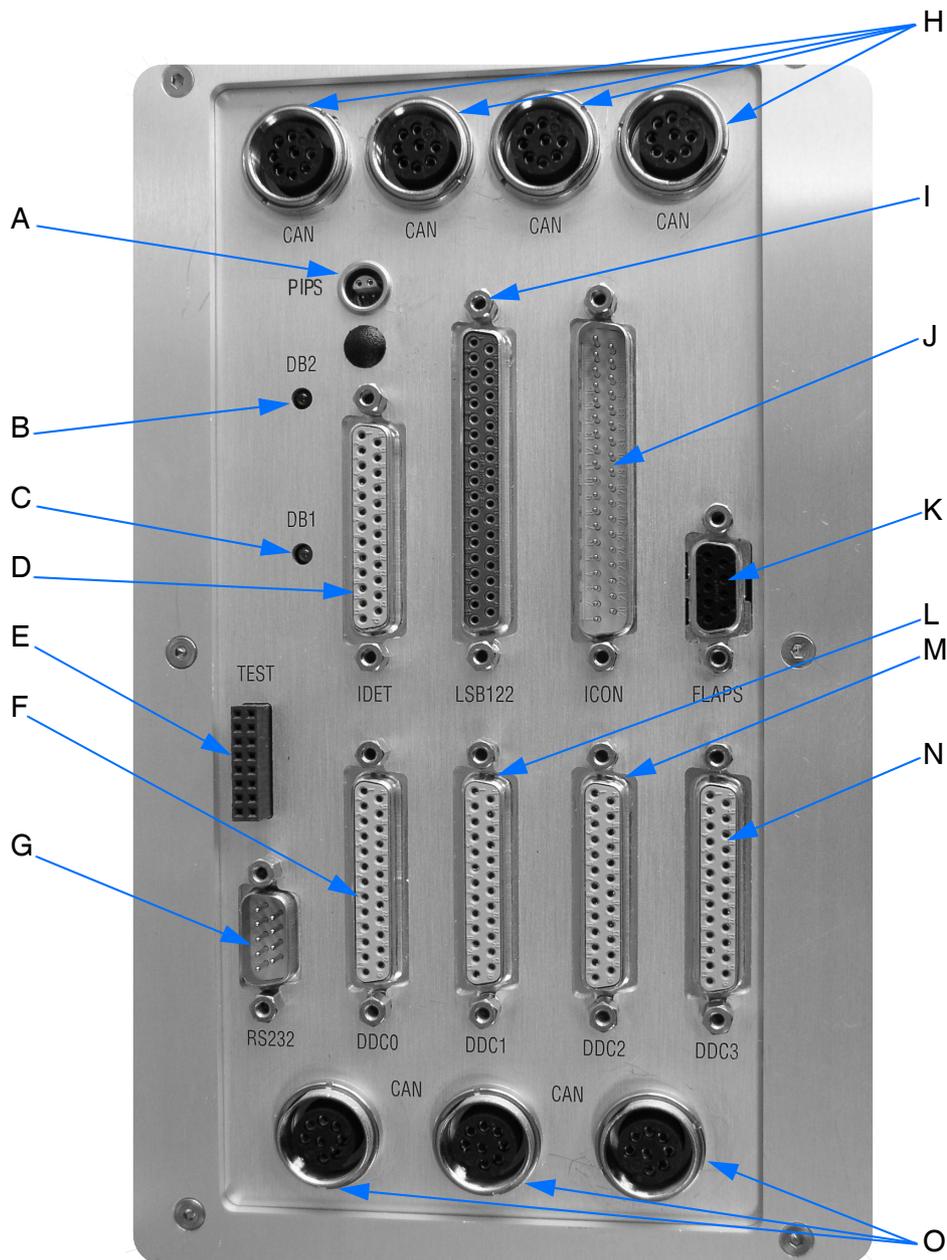


Figure 69: IFS 125 HR - Flange panel

### PIPS PORT

The PIPS port (A in figure 69) provides a connection to the differential pressure transducer. The sensor measures the pressure difference between the interferometer and sample compartment. The PIPS abbreviation means *Pressure Interferometer/Pressure Sample*. In case of spectrometers without any sample compartment the port should be capped by a special dummy plug.

**Note:** Note: Previous units have been equipped with 2 pressure input ports (PI and PS) for flexible hoses. These hoses cannot be disconnected at the ports.

## DB1/2 LED

The red DB1 (C in figure 69) is intended to be used for functions which have not yet been defined. The green DB2 LED (B in figure 69) is used to see whether data communication is performed between the flange panel and electronics panel. If the DB2 LED is ON, data are sent from the flange panel via CAN bus to the electronics panel. In case of a successful data communication the DB2 LED will be switched off again.

Sources, valves, pressure transducer and other accessories are controlled via the flange panel.

## IDET PORT

The IDET port (D in figure 69) provides a connection to the detector compartment. All internal detectors are connected to the IDET port which is functionally compatible to the DDC ports (0 - 3). The IDET abbreviation means *Internal Detector*.

## TEST PORT

The TEST port (E in figure 69) is intended for service and diagnostics. Do not connect any device to this port except for service purposes (for details see chapter 7).

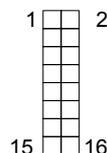


Figure 70: Test receptacle

### Pin assignment:

- 1 LASA (Laser A)
- 2 AGND (Ground for 1 + 3)
- 3 LASB (Laser B)
- 4 FWDLSW
- 5 DGND
- 6 BWDLSW
- 7 LASXAF
- 8 DGND
- 9 SCM+ (Scanner Voice Coil)
- 10 SCM- (Scanner Voice Coil)
- 11 DCANA
- 12 - 16 Spare

**Note:** Do not short-circuit any pins!

## DDC PORT 0/1/2/3

The ports DDC 0 to 3 (F, L, M and N in figure 69) are versatile ports to connect external optical modules and detectors. These ports include a complete CAN-Bus, transmit all remote trigger signals required and establish a complete connection to DDC compatible detectors. The DDC abbreviation means *Digital Detector Connection*.

DDC ports are typically used to connect bolometers, microscopes or other external detectors.

## RS232 PORT

The R232 port (G in figure 69) is a spare serial interface port for future use.

## CAN BUS

The CAN bus connectors on top of the flange panel (H in figure 69) automation unit control to the different compartments of the IFS 125HR, e.g. source, interferometer, sample, detector compartment). There is no specific order to be observed when using the CAN bus connectors, i.e. they can always be interchanged.

The bottom CAN bus connectors (O in figure 69) are used for external automation units like microscopes, user-specific switching mirrors etc. They are identical to the top ones with regard to their function.

## LSB122 PORT

The LSB122 port (I in figure 69) provides the connection to the laser and light switch signals of the scanner. It represents a direct connection to the interferometer compartment.

## ICON PORT

The ICON port (J in figure 69) controls the sources, valves and powers of the source rack (also see figure 71) which is located above the electronics unit.

## FLAPS PORT

The FLAPS port (K in figure 69) controls the flaps in front of and behind the sample compartment. Flaps are automatically controlled by the vacuum control function. In case of spectrometers without sample compartment the port should be capped by a special dummy plug.

## SOURCE CONTROL PANEL

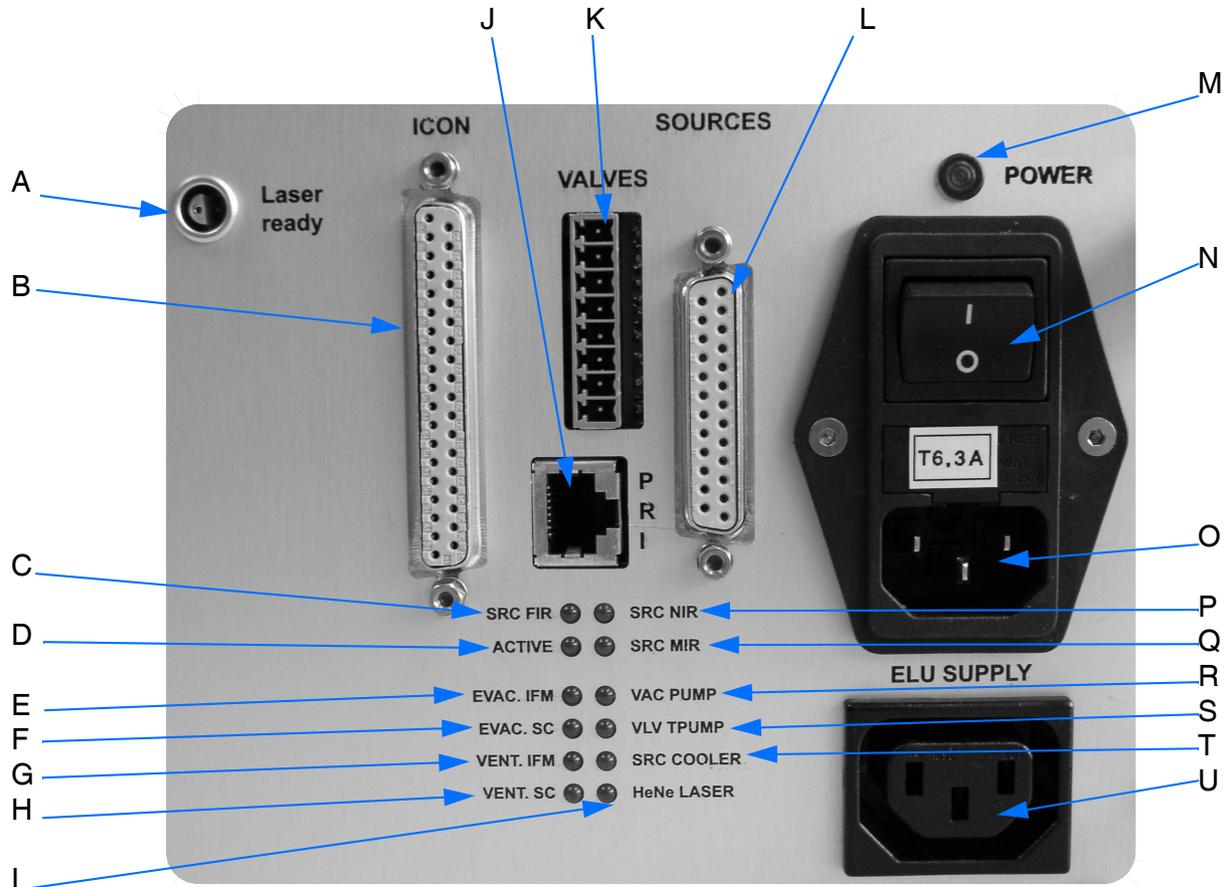


Figure 71: IFS 125HR - Source control panel

### LASER READY

The *Laser ready* connector (A in figure 71) receives the laser-ready signal from the HeNe power supply which is located beneath the HeNe laser tube.

**Note:** Always make sure that one end of the LAS/RDY cable is plugged into the corresponding source control panel connector and the other into the laser power supply connector. If unplugged, the *laser not ready* state cannot be detected.

## ICON PORT

This port (B in figure 71) is connected to the ICON connector at the flange panel (see figure 69). It transfers all control signals required for the source, valve and power control.

## SRC LED FIR/NIR/MIR

The green SRC LEDs (C, P and Q in figure 71) indicate the status of the internal sources:

- OFF = source off
- ON = source on
- BLINK = source broken

The abbreviation SRC means *Source*.

## ACTIVE LED

A blinking green Active LED (D in figure 71) indicates that the source control rack is properly operating.

## EVAC. LED IFM/SC

The green EVAC. IFM and SC LED (E and F in figure 71) indicate the status of the 2 valves used for evacuation:

- OFF = valve closed
- ON = valve open
- BLINK = valve not connected

## VENT. LED IFM/SC

The green VENT. IFM and SC LED (G and H in figure 71) indicate the status of the 2 valves used for venting:

- OFF = valve closed
- ON = valve open
- BLINK = valve not connected

## HE NE LASER LED

The green HeNe LASER LED (I in figure 71) indicates the status of the HeNe laser<sup>1</sup>:

- OFF = HeNe off
- ON = HeNe on
- BLINK = HeNe stabilizing

## PRI PORT

The PRI port (J in figure 71) is used to connect the absolute pressure sensor. It must not be interchanged by the ETH connector.

## VALVES PORT

The valves port (K in figure 71) provides a control connection to the 4 valves which control the vacuum for the IFS 125HR.

## SOURCES PORT

The sources port (L in figure 71) is used to establish the connection to the sources located in the IFS 125HR source compartment.

## POWER SUPPLY INDICATOR

If the power supply indicator (M in figure 71) lights red, power is available to the instrument.

## MAIN POWER SWITCH

This main power switch (N in figure 71) is used to switch the spectrometer on and off. This switch interrupts the primary voltage supply.

**Caution: If you have switched off the spectrometer, wait at least 30 seconds before switching it on again. This avoids peaks in the initial current, which could blow the fuses and/or damage the power switch.**



**Caution: Additionally, too short an interruption of power may lead to an improper reset action of the electronics controller.**

---

1. Correct operation can only be ensured if the HeNe laser power supply is connected to the *LASER PS* socket (A in figure 73), and the LAS/RDY cable is installed (A in figure 71).

## MAINS POWER CONNECTOR

The mains power connector (O in figure 71) is a power input which is connected to the mains.

Replace the power cord if any damage to the insulation, connectors or cable is visible. Do not repair the power cord. Replace the power cord only by cords rated for at least 250VAC, 10A. The cord must be approved at least by your local authority, i.e. UL for USA, CSA for Canada or VDE for Europe.

## VAC PUMP LED

The green VAC PUMP LED (R in figure 71) indicates the status of the vacuum pump unit. By means of this LED it is possible to check the vacuum pump operation, provided the starter box is connected to the *Vacuum Pump* socket (see figure 73). The abbreviation VAC means *Vacuum*.

## VLV TPUMP LED

The green VLV TPUMP LED (S in figure 71) indicates the status of the turbo pump valve, which can optionally be installed. By means of this LED it is possible to check the turbo pump valve operation, provided this unit is connected to the *Valve Turbopump* socket (see figure 73). The abbreviation VLV means *Valve*.

## SRC COOLER LED

The green SRC COOLER LED (T in figure 71) indicates the status of the source cooler unit. By means of this LED it is possible to check the source cooler operation, provided this unit is connected to the *Source Cooler* socket (see figure 73). The abbreviation SRC means *Source*.

## ELU SUPPLY

The ELU supply port (U in figure 71) is the power outlet for the electronics unit rack. This port is switched off together with the main power switch (N in figure 71).

## SOURCE SUPPLY STATUS INDICATORS

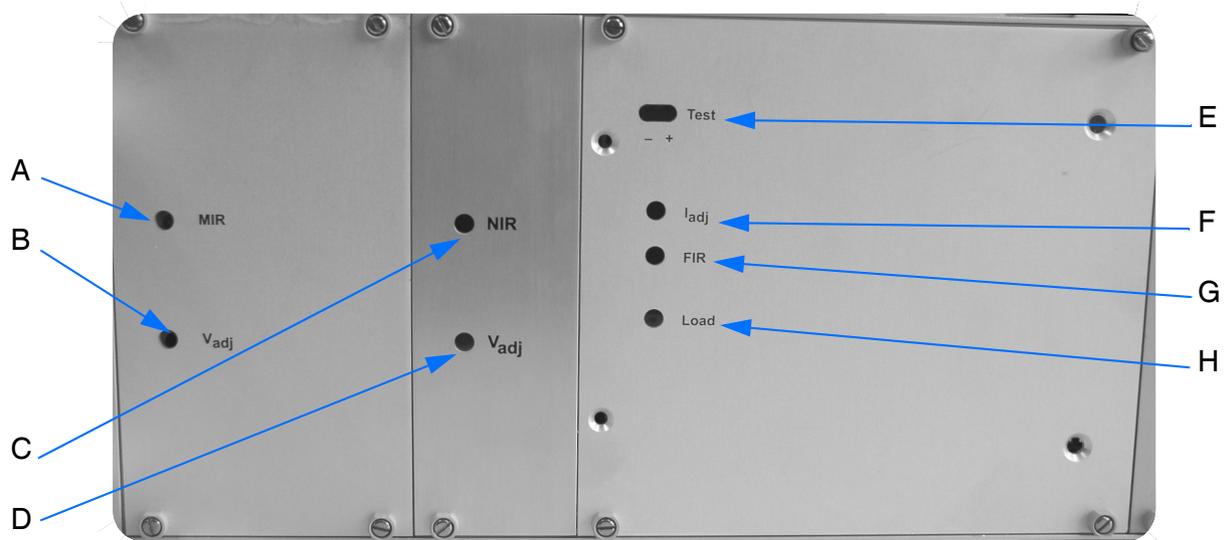


Figure 72: IFS 125HR - Source supply status indicators

### MIR/NIR/FIR LED

The green MIR/NIR/FIR LEDs (A, C and G in figure 72) indicate the ON/OFF status of the source power supplies, if the respective options have been installed.

### VADJ PORT

The  $V_{adj}$  ports (B and D in figure 72) enable voltage adjustment of source voltages, i.e. a higher voltage yields to a higher signal but decreases the source lifetime. It is recommended not to modify the pre-adjustments made by Bruker.

### TEST CONNECTOR

The TEST connector (E in figure 72) enables the measurement of the FIR source voltage for diagnostic purposes.

### IADJ PORT I

The  $I_{adj}$  port I (F in figure 72) enables the FIR current adjustment. It is recommended not to modify the pre-adjustments made by Bruker.

## LOAD LED

The LOAD LED (H in figure 72) is on if current flows through the FIR source.

## PERIPHERAL CONTROL PANEL

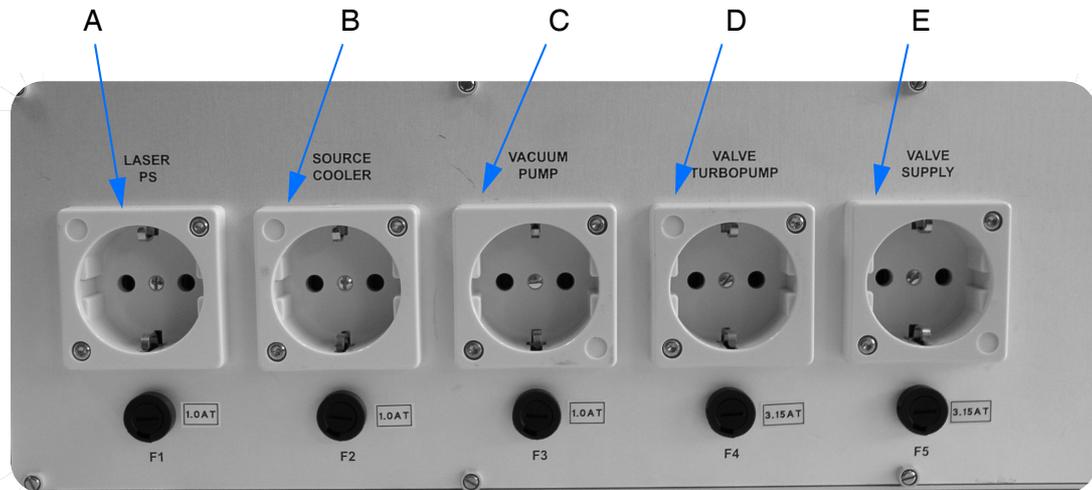


Figure 73: IFS 125HR - Peripheral control panel

The IFS 125HR peripheral control panel at the rear side of the source supply unit includes different power sockets with the corresponding fuse holders. The line voltage and frequency of these sockets corresponds to the one supplied at the mains power connector (O in figure 71). **Make sure that the devices connected to any of these sockets comply with the voltage and frequency values of the mains power at connector O.**

## LASER PS

The laser power supply should be connected to the LASER PS power socket (A in figure 73). Only in that case will the total run time of the laser be counted correctly.

## SOURCE COOLER

The source cooler unit should be connected to the SOURCE COOLER power socket (B in figure 73).

**Note:** If the instrument is configured for 115V operation (see *Power Supply* in chapter 3), the source cooler **must not** be connected to this power socket. Directly connect it to the mains power supply.

## VACUUM PUMP

The VACUUM PUMP power socket (C in figure 73) is required for the relay to control the vacuum pump. Connect the starter box to this socket.



**Caution:** Never connect the power cord of the vacuum pump directly to the VACUUM PUMP socket. Always use a relay of sufficient power rating in between.

## VALVE TURBO PUMP (OPTIONAL)

The turbo pump valve (optional) should be connected to the VALVE TURBO PUMP power socket (D in figure 73).

## VALVE SUPPLY

The internal vacuum valves must be connected to the VALVE SUPPLY power socket (E in figure 73).

# SAMPLE PREPARATION

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## GAS ANALYSIS

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To obtain an infrared spectrum of a gaseous sample a gas cell with windows at each end is required. It is important to select a suitable window material (e.g. KBr, NaCl or CaF<sub>2</sub>) that does not absorb infrared light. The cell usually has an inlet and outlet port with a tap to facilitate the filling with the gas to be analyzed.

Simple demountable cells (50mm to 100mm) are recommended for strongly absorbing gases. For diluted samples (ppm to ppb concentrations) a long path cell should be used. The long path cell reflects the IR beam several times through the sample using a set of mirrors positioned on the opposite ends of the cell.

**Note:** The cell thickness, gas pressure inside the cell, and the molar absorptivity determine the peak intensity.

## STANDARD SPECTROSCOPY

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The IFS 125HR spectrometer can also be used for standard spectroscopic applications. In this case proper sample preparation is essential to obtain good and meaningful spectra. This section describes several sample preparation methods that cover a wide range of samples. It will help you to select the most suitable sample preparation method for a given sample.

The adequate sample preparation method depends on the state of aggregation and the absorptivity of the sample in the wavelength range of the spectrum. Irrespective of the physical sample condition, the sample material has to be homogeneous as variations in concentration or composition within the selected frequency range can result in misleading or erroneous data. Sometimes the trial-and-error procedure is required to obtain an acceptable spectrum.

## State of Aggregation

Depending on the sample's state of aggregation there are different sample preparation and measurement methods. If you have to analyze a solid sample, you can either prepare a solution, a Nujol mull or a KBr pellet. Liquid samples can be analyzed either as a thin film between plates or within a liquid cell. Gaseous samples require dedicated cells with different path lengths.

## Absorptivity

The characteristic absorption features of the sample are an important factor when selecting a suitable sample preparation method. To obtain meaningful spectra, strongly absorbing samples must either be:

- very thin or
- diluted by a solvent or powder which is poorly absorbing.

According to Beer's Law, the absorbance (i.e. peak intensity) in an absorbance spectrum is directly proportional to the component concentration in the sample, path length of the sample and the absorptivity.

$$A = \epsilon bC$$

Symbol	Description	Typical Units
A	Absorption at a given wavelength	None
$\epsilon$	Molar absorptivity (a proportionality constant)	$l \cdot \text{mol}^{-1} \cdot \text{cm}^{-1}$
b	Sample path length (length for samples in a cell or sample thickness for films, pressed pellets)	cm
C	Component concentration in the sample	mol/l

If the absorbance  $A$  (i.e. peak intensity) is too strong, decrease the sample concentration  $C$  by diluting it or diminish the path length  $b$  by reducing the sample thickness. If the absorbance  $A$  (i.e. peak intensity) is too weak, increase the sample concentration  $C$  or the path length  $b$  accordingly to obtain a reasonable peak intensity.

To find out whether a sample is strongly absorbing in the wavelength range of interest you have to acquire a test transmission spectrum. The figure below shows a transmission spectrum of a strongly absorbing sample.

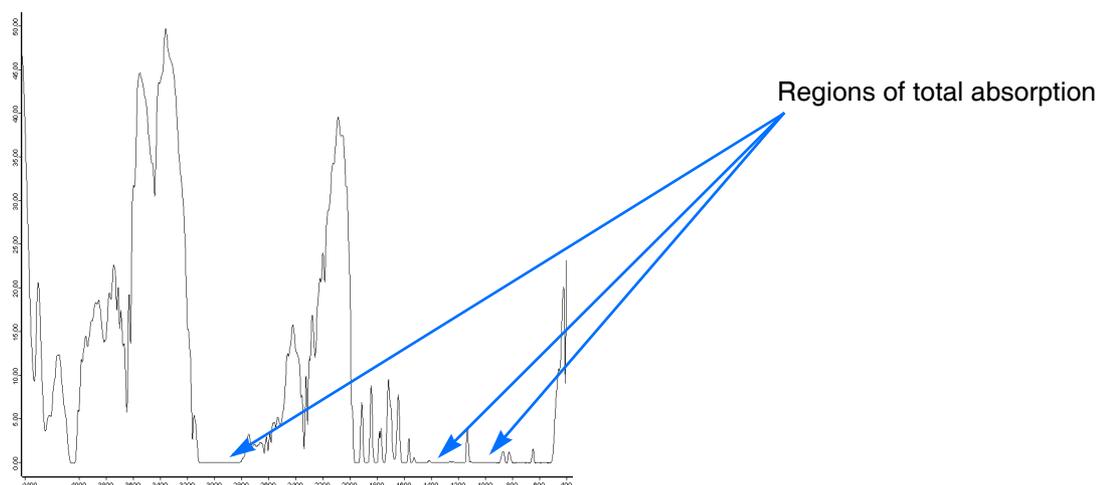


Figure 74: Transmission spectrum of a strongly absorbing sample

## SAMPLE PREPARATION METHODS

There is a large number of possible sample preparation methods. A detailed description of all these methods to prepare samples used for analysis would be beyond the scope of this manual. Therefore, this chapter only describes the most common methods, and provides further information on how to select the right preparation method.

To evaluate the most adequate preparation method (for a particular sample) we recommend trying more than one sample preparation method, and acquiring spectral data. These data serve as a basis for the most adequate sample preparation method in each particular case. In case of doubt ask your application specialist.

Some of the most common sample preparation methods are:

- No sample preparation (e.g. self-supporting film or measurement using a micro ATR accessory)
- Thin film of liquid sample solution film between 2 IR-transparent<sup>1</sup> plates (NaCl, KBr).
- Preparing a solution
- Preparing a Nujol mull<sup>2</sup>
- Pressing a KBr pellet
- Liquid cell and gas cell (see *Gas Analysis* section)

1. i.e. IR-transparent within the frequency range of interest

2. A mull is a mixture (suspension) of two substances, one of which is finely divided and dispersed in the other.

**Note:** Most of the sample preparation methods described involve the use of hygroscopic materials (such as NaCl or KBr). If these materials come in contact with water or alcoholic solvents, they begin to dissolve or become cloudy and thus impair the measurement results. Avoid all sources of water and even alcohol (ethanol and methanol).

## No Sample Preparation

The easiest samples to analyze are film and polymer samples with a thickness of less than approx. 100 micrometers. They can be simply placed into a magnetic holder and immediately scanned. The same procedure can be used for samples which can be sliced to an appropriate thickness.

A large number of solid and liquid samples can also be analyzed without requiring a preparation using a micro-ATR accessory. Attenuated Total Reflectance (ATR) units are a very versatile accessory for FT-IR measurements. In many cases, the micro-ATR unit can be used for liquid and semi-liquid materials instead of constant path transmission cells and salt plates. In addition, this measurement accessory can also be used for analyzing polymer films, pastes and powders.

Due to the reproducible effective path length, they are well-suited for both qualitative and quantitative analyses. Depending on the sample material and analysis objective there are different ATR-crystal materials (e.g. ZnS, ZnSe, Ge and diamond). The sample penetration depth ranges between 0.1 and 2 $\mu$ m and depends on the wavelength, the refractive index of the ATR-crystal material and the incidence angle of the beam. For more information on attenuated total reflectance refer to the respective technical literature.)

## Thin Film between two Plates

Preparing a thin film of a liquid sample between two IR-transparent plates is an easy sample preparation method. Use this method if your sample is either some sort of liquid or oil. An advantage of this method is that only a small amount of the sample is required.

- Apply a drop of the sample on one of the plates using a pipet.
- Place a second plate on top and make a quarter turn to obtain an even film of the liquid sample. Sandwich the plates carefully to remove all air bubbles. Note that these plates are very fragile and can easily break. The space between the two plates is very small (typically < 0.01mm).
- If the sample amount proved to be too much, separate the plates, clean one side and put the plates together again.
- Slot the plates into the sample holder of the spectrometer and start the measurement.

**Note:** The plates (made of NaCl or KBr) are extremely moisture sensitive. Therefore, do not use samples which contain water. Always keep the plates dry, clean them only by using chloroform or high purity acetone, and polish them carefully after each use.

In the course of time the plates will absorb moisture from the atmosphere and deteriorate. Therefore, proper storing in a tightly sealed bell jar is extremely important.

## Solid Sample as Solution

Use this sample preparation method if your sample is a soluble solid (e.g. a soluble powder). To obtain an IR spectrum you have to prepare a concentrated solution of your sample using a suitable solvent. The solution concentration required to obtain a good spectrum depends on the sample.

- Dissolve the sample or sample powder in a solvent and apply the sample solution between two support plates, as described above. Depending on the available amount of sample material you can either apply a small amount of your sample powder directly on the plate and add one drop of the solution, or dissolve the sample in a test tube and apply the solution by a pipet on the plate.
- Another possibility is to apply the sample solution on an IR-transparent plate and allow the solvent to evaporate leaving a thin sample film on the plate. Slot the plate into the sample holder of the spectrometer and start measuring.
- You can also fill the sample solution into a liquid cell and acquire a sample spectrum. To acquire a background spectrum measure the liquid cell which contains the solvent only. The volumes of these liquid cells are between 0.1 and 1 ml. Micro cells with a much lower capacity are also available.
- Do not forget to acquire a background spectrum of the solvent as well.

**Note:** The plates (made of NaCl or KBr) are extremely moisture sensitive. (See above.)

When preparing a solution the major problem is selecting an appropriate solvent. Most solvents have a strong absorptivity and thus their peaks superimpose those of the solute. Therefore, make sure that the solvent used is poorly absorbing in the wavelength range of interest. Use only spectrophotometrically pure solvents, i.e. solvents which are not infrared active in the spectral range of interest, to avoid bands resulting from solvent.

No solvent is perfect but if some information about the sample is known, the solvent can be selected accordingly. Commonly used solvents are carbon tetrachloride, carbon disulphide, chloroform, cyclohexane, acetonitrile, and tetrachloroethylene. Never use water as solvent, for water dissolves the salt plates and exhibits a broad OH-peak which covers a lot of other peaks that might be of interest for you. Refer to the relevant literature for the absorptivity of various solvents.

## Preparing a Mull

This sample preparation method is useful if the solid sample is ground into fine particles and no suitable solvent is available. In this case the sample powder is suspended in a mulling agent, i.e. a liquid in which the solid is not soluble. A suitable mulling agent is Nujol, some sort of paraffin oil, which is transparent in the infrared range except for narrow bands at  $2900$ ,  $1450$  and  $1375\text{cm}^{-1}$ . An alternative mulling agent, which does not absorb in these ranges, is a perfluorokerosene agent (e.g. Fluorolube.)

This method is simple and can easily be performed. The disadvantage is the interference resulting from the absorption bands of the mulling agent. Both Nujol and Fluorolube have characteristic spectral features and in most cases have to be used as a pair in order to generate a complete MIR spectrum. Nujol is used below  $1330\text{cm}^{-1}$ , Fluorolube above  $1330\text{cm}^{-1}$ .

- Put a small amount of solid sample in an agate mortar.
- Grind the sample thoroughly into fine powder (particles smaller than 500 mesh), using a pestle.

**Note:** A common mistake when preparing a Nujol mull is to grind the powder too quickly. A mull prepared from a coarsely ground solid will only yield a poorly resolved spectrum. Grinding the sample into very fine particles is also important to reduce light scattering and salt plate scratching.

- Add 1 or 2 drops of Nujol. Be careful not to add too much Nujol.
- Mix the ground sample with the mulling agent until a uniform paste with a vaseline-like consistency is formed.
- Apply some mull on the surface of a NaCl plate using a suitable tool (e.g. a small spatula or a rubber policeman). Be careful not to scratch the plate.
- Place the second plate over the mull. To ensure an even and thin sample thickness between the plates, rotate and press the plates together in order to squeeze out the excess of the paste. Exclude also air bubbles.
- Slot the plates into the plate holder installed in the spectrometer sample compartment and start measuring.
- Do not forget to acquire a background spectrum of the pure Nujol as well.

## Pressing a Pellet

This sample preparation method is very useful for solid samples in terms of the information resulting from an IR spectrum, as KBr is significantly more IR transparent than most solvents or Nujol oil. KBr has no absorption in the range from  $4000\text{cm}^{-1}$  to  $250\text{cm}^{-1}$ , which produces a good sample spectrum (i.e. a spectrum that does not contain spectral information about the dispersing agent).

The success of this method strongly depends on the grain size of the ground sample. Grind the sample as fine as possible (particle size of at least 200 mesh, better 500 mesh) to minimize the infrared light scattering on the particle surface, also called Christiansen effect. This effect is caused by a refraction index mismatch between the salt (KBr) and sample powder that leads to reflections at the salt-sample interface. Therefore, proper grinding is required to ensure a good contact between KBr and sample powder.

Another important factor in case of this method is to keep everything moisture free as the KBr material is hygroscopic. To prevent the KBr material from absorbing moisture, keep the KBr material and the die in a drying oven at a temperature of 50 to 60°C. Failure to do so will result in cloudy pellets that yield distorted spectra. A correctly prepared KBr pellet will be transparent to IR light.

To sum it up, the KBr pellet technique yields good quality spectra with a wide spectral range and no interfering peaks. Disadvantages include tedious and time-consuming sample preparation and clean-up, interference of water bands (3960 to 3480 $\text{cm}^{-1}$  and 1950 to 1300 $\text{cm}^{-1}$  and below 500 $\text{cm}^{-1}$ ) and in some cases structural changes caused by high pressure applied to the KBr/sample mix.

- Put a small amount of the sample in an agate mortar and grind it as fine as possible.
- Add a spatula full of oven-dry KBr material to the ground sample and mix it until a uniform mixture is obtained. Do not grind the mixture as this may increase the absorption of water by KBr.

**Note: A common mistake is to use too much sample. The sample concentration of the sample in KBr should be in the range of 0.2% to 1% (i.e. typically a 300:1 dilution by mass).**

- Transfer the mixture into a die of a hydraulic or hand press and expose it to very high pressure (ca. 20,000 psi) for a few minutes (2 to 5 minutes). The result should be a translucent pellet with an ideal thickness of 0.5 to 1mm.
- Carefully remove the pellet from the die, place it on the pellet holder and put the pellet holder into the spectrometer sample compartment.

**Note: The KBr pellet is very hygroscopic and fragile. Handle it with care and use gloves to avoid contact with moisture from your hands. Measure the KBr pellet immediately after removing it from the press as the pellet will quite quickly begin to absorb moisture from the air and becomes cloudy.**

## Liquid cell

Liquid cells produce excellent results for most liquids. Especially for liquid samples that are very volatile, using a liquid cell is highly recommended. A liquid cell consists of two IR transparent windows with a precision spacer in between. One of the windows has two drilled holes for introducing and evacuating the liquid. A large number of cell options are available, including permanently sealed cells, demountable cells with different window material and a wide selection of spacers.

**Note:** Consider that KBr is hygroscopic and the path length of the KBr cell will change when exposed to a wet sample (this may affect quantitative results). In addition, water will reduce the cell throughput by clouding the windows.

Many liquid cells contribute a fringe pattern to the spectrum. Matching the refraction index of the window material with that of the sample can minimize this effect.

# GLOSSARY

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H

<b>Alignment</b>	The adjustment of optical components, e.g. mirrors and lenses, to bring all their optical axes in line to maximize performance.
<b>Aperture</b>	The aperture wheel contains accurately etched holes to admit light of defined divergence into the spectrometer.
<b>Beam splitter</b>	A device used to produce two separate beams from one incident beam. Generally a coated substrate that reflects and transmits approximately equal portions of the incident radiation.
<b>Calibration</b>	The entirety of working steps to define the relation between analyte concentrations and the corresponding standard measurement values. Under specified conditions the analyte concentrations are indicated by an instrument, measuring system, or values which have been evaluated by material measuring or reference material.
<b>Collimated light</b>	Light for which all flux lines are parallel.
<b>Cross-over cable</b>	Cable used for the direct connection of two workstations Network Interface Cards (NICs). NICs have dedicated lines to send and receive data. A crossover cable connects from the send line of one NIC to the receive line of the other NIC.
<b>Detector</b>	A device that converts incoming light into an electrical signal.
<b>Diffuse reflection</b>	The scattering of light at all angles from a point of reflection. Diffuse reflection techniques are used to analyze rough-surfaced solid samples.
<b>Ethernet</b>	Ethernet is the most widely installed Local Area Network (LAN). A LAN is a network of interconnected workstations sharing the resources of a single processor or server within a relatively small geographic area (i.e. an office building). Ethernet is a set of hardware and signaling standards used for LANs. The most commonly installed systems are 10/100 BaseT.
<b>Fiber-optic cable</b>	Cable made of strands of thin fibers (glass or plastic wire) that transmits pulses of light. Optical fiber carries much more information than conventional copper wire and is in general not subject to electromagnetic interference.
<b>FIR</b>	<b>Far InfraRed</b> ; covers the spectral range from 400 to about $5\text{cm}^{-1}$ wavenumbers. It is about vibrational frequencies of both backbone vibrations of large molecules, as well as fundamental vibrations of molecules that include heavy atoms (e.g. inorganic or organometallic compounds) and pure rotational vibrations.

<b>Fourier Transform</b>	The mathematical transformation used in FT spectroscopy to convert an interferogram into a spectrum. Essentially, Fourier Transform decomposes or separates a waveform or function into sinusoids of different frequency which sum to the original waveform. It identifies or distinguishes the different frequency sinusoids and their respective amplitudes.
<b>Frequency</b>	The frequency is the number of periods per time unit. Since all electromagnetic waves travel at the speed of light (depending on the particular medium), the frequency corresponding to a given wavelength can be calculated as: $\nu = c/\lambda$ .
<b>FT-IR</b>	<b>Fourier Transform InfraRed Spectroscopy</b> A method to obtain infrared spectra of a sample using an interferometer and then performing a Fourier transform on the resulting interferogram to calculate the spectrum.  In case of an FT-IR spectrometer infrared light emitted from a source is directed to an interferometer, which modulates the light. Leaving the interferometer the light passes through the sample compartment (and also the sample) and is focused onto the detector. The signal measured by the detector is called the interferogram.
<b>Fuse</b>	Fuses and circuit protectors protect electrical devices and components from overcurrents and short circuits. This is achieved automatically by the melting of an internal melting element through which a fault current flows. Both components are rated so as to reliably interrupt current flow when it reaches a predictable magnitude for a fixed time period. For all practical purposes, a fuse or protector is invisible to a properly operating circuit.  A fuse switches or blows when a high short-circuit or fault current causes an irreversible, physical separation of the melting element. As the weakest element in a circuit, the fuse/protector resistivity increases, eventually causing the melting point of the melting element to be reached. The element then changes state from a solid to a liquid (or even gas) within a defined time period.
<b>Gateway address</b>	A gateway is a network point that acts as an entrance to another network. It is used to control traffic on the facility's network. A gateway address is the address of a particular gateway on a network.
<b>Globar</b>	An infrared source which consists of a pin made of silicon carbide (SiC). This pin is electrically heated and emits infrared light.

<b>Interferogram</b>	<p>A plot of detector signal as a function of optical path length difference. Spectrometers are equipped with a broadband light source, which yields a continuous infinite number of wavelengths. The interferogram is the continuous sum, i.e. the integral of all the interference patterns produced by each wavelength. This results in the intensity curve as function of the optical retardation.</p> <p>At the zero path difference of the interferometer (<math>\Delta x=0</math>) all wavelengths undergo constructive interference and sum to a maximum signal. As the optical retardation increases different wavelengths undergo constructive and destructive interference at different points, and the intensity therefore changes with retardation.</p> <p>For a broadband source, however, all the interference patterns will never be simultaneously in phase except at the point of zero path difference, and the maximum signal occurs only at this point. This maximum in the signal is referred to as the centerburst. Any dispersive element in the beam path may lead to <i>chirping</i> of the centerburst.</p>
<b>Interferometer</b>	<p>Inside the interferometer the light beam is splitted into two beams by the beam splitter. The most-commonly used Michelson interferometer consists of a beam splitter, stationary and movable mirror. Due to the continuous movement of one mirror the optical path lengths of the two separated beams changes in time. Interference is effected when the two light beams are recombined.</p>
<b>IP address</b>	<p>Network address of a workstation or network. IP addresses are always in the form of 4-number fields separated by dots. Each number field represents 1 byte. Values can be in the range of 0-255. The numbers on the left of the string define the network, the numbers on the right define the individual workstation or Network Interface Card (NIC).</p>
<b>KBr pellet</b>	<p>A pellet prepared by grinding the sample, diluting it in KBr and pressing it into a transparent disc. The KBr pellet is directly placed into the infrared beam for analysis.</p>
<b>Lambert-Beer Law</b>	<p>Linear approximation for the relation between the absorbance of a sample and its concentration used to predict unknown concentrations. Mathematically expressed by <math>A = abc</math>, where <math>A</math> represents absorbance, <math>a</math>, <math>b</math>, and <math>c</math> are absorptivity or extinction coefficient, path length and concentration.</p>
<b>Laser</b>	<p>The laser is a coherent source of monochromatic radiation. It is an essential part of the interferometer system. Due to laser light interference the position of the movable mirror (see <i>Interferometer</i>), and the data sampling positions are determined.</p>
<b>Micrometer (<math>\mu\text{m}</math>)</b>	<p><math>10^{-6}</math> of a meter; a micron</p>
<b>MIR</b>	<p><b>Mid InfraRed</b>; covers the spectral range from 4,000 to <math>400\text{cm}^{-1}</math> wavenumbers. In this range fundamental vibrations are typically excited.</p>
<b>NIR</b>	<p><b>Near InfraRed</b>; covers the spectral range from 12,800 to <math>4,000\text{cm}^{-1}</math> wavenumbers. Overtones and combination vibrations are excited.</p>

Optical path	The distance between two points in the light beam in longitudinal direction multiplied by the refractive index of the medium.
Reflectance	Reflectance is the ratio of the radiation energy reflected from a surface to the radiation energy incident on the surface.
Reflection	The process by which incident illumination reacts with the sample and is converted to radiation energy that subsequently travels back from the sample surface at a defined wavelength.
Relative humidity	The amount of water vapor contained within an air sample, expressed on a scale of 0 - 100%.
Resolution	<p>Resolution in FT-IR is determined by the maximum optical path difference reached in the measurement of an interferogram. The spectral resolution corresponds to the minimum possible spectral distance between 2 adjacent spectral lines which can be resolved by the spectrometer. It is produced by the instrumental spectral line shape and the line width of the sample's absorption.</p> <p>The instrumental line shape is reciprocally related to the travel distance of the movable mirror in the interferometer, and also influenced by the apodization function and divergence in the interferometer. The higher the spectral resolution (smaller values), the higher the noise in the spectrum at a given measurement time.</p>
Sample	Special kind of substance which is put into the sample position and measured.
Signal-to-noise ratio	Ratio of the radiance measured to the peak-to-peak noise created by the detector and associated electronics. Parameters affecting the signal, e.g. reflectance, must be defined to make the value meaningful.
Source	Emits (infrared) light.
Spectrometer	From the Latin word <i>specere</i> meaning image, and the Greek word <i>metron</i> meaning to measure. A spectrometer uses some sort of mechanical or electrical detection device to obtain the infrared spectrum of a sample. It contains a source of infrared radiation, a sample compartment to allow the radiation to interact with a sample, a detector for radiation and units to determine and display the intensity of radiation.
Spectrum	A spectrum is an image of radiation energy dispersed into its wavelength constituents or a two-dimensional plot of radiation energy or radiation energy ratio versus wavelength. It includes a set of absorption, reflection or transmission values which have been measured by an IR spectrometer based on defined wavelengths. The features in an infrared spectrum correlate with the presence of functional groups of molecules of a sample.
Subnet mask	Also called sub-networks, they are used to partition network addresses for efficiency and security. Subnet masks work by 'masking' some number of less significant address bits on all of the workstations in the subnetwork.

Transmission	A portion of the incident illumination energy passes directly through the sample without any interactions with electrons or molecules in the sample. Another portion of energy is absorbed and re-emitted over and over again in the same direction as the incident illumination. Transmission is the process of these events. In either case, the photons are <i>transmitted</i> through the sample.
Transmittance	Transmittance is the ratio of the beam energy transmitted through a sample to the beam energy incident on the surface of the sample.
Validation	During validation the x-axis (frequency) and y-axis (transmission, reflection) are verified by transmission or reflectance standards which may be included in the internal validation unit. The validation can be performed at individual time intervals by the application software.
Wavenumber	The term <i>wavenumber</i> is the commonly used dimension for the x-axis in FT-IR spectroscopy. It is defined as $\tilde{\nu} = \frac{1}{\lambda_0}$ . The unit is $\text{cm}^{-1}$ .
Wavelength	The wavelength $\lambda$ is the distance between two maxima on a sinusoidal wave, i.e. the distance traversed by one period of an electromagnetic wave. The wavelength depends on the refractive index of the medium which the electromagnetic wave travels through.



# SERVICE ADDRESSES

Bruker Optik has an international network of branch offices and representations to ensure a competent customer service throughout the world. The following list includes the addresses of Bruker headquarters.

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No responsibility can be taken for the correctness of this information. Subject to changes.





FT-IR  
 FT-NIR  
 FT-Raman  
 BioMed  
 TD-NMR  
 Software

## EC-DECLARATION OF CONFORMITY

**The undersigned, representing the following manufacturer**

Manufacturer: BRUKER OPTIK GMBH
Address: D-76275 Ettlingen, Rudolf-Plank-Straße 27

**herewith declares that the product**

Product identification: <div style="text-align: center; font-weight: bold; margin-top: 5px;">IFS 125HR</div>
---

**is in conformity with the provisions of the following EC directive(s)**  
 (including all applicable amendments)

Reference no.	Title
73/23/EWG	Directive of the commission from February 19 <sup>th</sup> , 1973 (Low Voltage Directive)
89/336/EWG	Directive of the commission from May 3 <sup>rd</sup> , 1989 (Electromagnetic Interference Directive)
92/31/EWG	Directive of the commission from April 28 <sup>th</sup> , 1992 (Amendment Electromagnetic Interference)
93/68/EWG	Directive of the commission from July 22 <sup>nd</sup> , 1993 (Amendment Electromagnetic Interference/Low Voltage Directive)
98/13/EG	Directive of the commission from February 12 <sup>th</sup> , 1998 (Amendment Electromagnetic Interference)

**and that the standards and / or technical specifications referenced overleaf have been applied.**

**Last two digits of the year in which the CE marking was affixed: 04**  
 (when compliance with the provisions of the Low Voltage Directive 73/23/EWG is declared)

Ettlingen

June 7, 2003

.....  
 (Place)

.....  
 (Date)

*A. Simon*  
 .....  
 (Signature)

Dr. Arno Simon, Development Manager

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 (Name and function of the signatory empowered to bind the manufacturer or his authorized representative)

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**References of standards and/or technical specifications applied for this declaration of conformity, or parts thereof :**

**Harmonized standards:**

No.	Issue	Title	Parts(1)
EN 61326:1997 +A1:1998+A2:2001	March 2002	Electrical equipment for measurement, control and laboratory use – EMC requirements	1
EN 61000-3-2:2000 +Corrigendum 1	December 2001	Electromagnetic compatibility; Part 3-2: Limits - Limits for harmonic current emissions	3-2
EN 61000-3-3:1995 +Corrigendum:1997+ A1:2001	May 2002	Electromagnetic compatibility; Part 3-3: Limits - Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current $\leq 16A$	3-3
EN 61010-1:2001 (2 <sup>nd</sup> Edition)	August 2002	Safety requirements for electrical equipment for measurement, control and laboratory use; Part 1: General requirements	1
EN 60825-1:1994+ A1:2002 + A2:2001	October 2003	Safety of laser products; Part 1: Equipment classification, requirements and user's guide	1

**Other standards and/or technical specifications:**

No.	Issue	Title	Parts (1)

**Other technical solutions, the details of which are included in the technical documentation or the technical construction file:** .....

**Other references or information required by the applicable EC directive(s):**  
.....

(1) Where appropriate, the applicable parts or clauses of the standard or the technical specification shall be referenced.



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